GOA UNIVERSITY
Taleigao Plateau, Goa 403 206

M I N U T E S

of the 14th Meeting of the

X ACADEMIC COUNCIL

Day & Date

Friday, 13th October, 2023

Time

10.00 a.m.

Conference Hall
Administrative Block
Goa University

	4. The House did not approve the proposal for a Certificate Course on Data Analytics. It was informed that the Certificate Courses may be offered by Colleges at their level and issue Certificates for such Courses without the Goa University Name and Logo. 5. The proposed minor corrections to the Course on "Cyber Security'' was approved. **(Action: Assistant Registrar Academic PG)**
D 3.10	**Minutes of the Board of Studies in Data Science meeting held on 02.08.2023.** The Academic Council approved the minutes of the meeting of the Board of Studies in Data Science held on 02.08.2023 with the following suggestions: 1. Part A, i, the Programme Structure and Syllabus for MSc Integrated Computer Science, Economics and Decision Sciences for the batches already admitted under Ordinance OB-32 was approved. 2. Part B, ii, Guidelines for Dissertation/Project at VI Semester for MSc Integrated was approved. 3. With regards to the Implementation of NEP, 2020 for the next academic year 2024-25, it was resolved to hold a meeting with the Vice-Chancellor and NEP Committee members of Goa University to arrive at a consensus on how to implement NEP for the M.Sc. Integrated Programme leading to specialization in Data Science, Computer Science, Economics and Decision Science. 4. It was resolved to notify that Ordinance OB-32 shall be applicable to the students admitted to the MSc Integrated Programme during 2023-24. **(Action: Assistant Registrar Academic PG)**
D 3.11	**Minutes of the Board of Studies in Mathematics held by circulation on 12.09.2023.** The Academic Council approved the minutes of the Board of Studies in Mathematics held by circulation on 12.09.2023 with the following suggestions. The Chairperson was requested to incorporate the following suggestions/modifications made by the members with respect to the syllabi of the PG Diploma in Advanced Statistics: 1. Revise "Learning Outcomes" to "Course Outcomes" and present 4 to 6 outcomes utilizing verbs from Bloom's Taxonomy. 2. Practical component of the Course to be verified; Hours for a 4 Credit Practical Course to be 120 instead of 60 hours, number of hours to be indicated. 3. One more Elective Course to be proposed under Semester I. 4. All Course to be set at Level 500. The Chairperson (Vice-Chancellor) was authorised to approve the revised Syllabus on behalf of the Academic Council. The House further resolved to advise the Principal of Government College, Sanquelim, to offer the PG Diploma Programme in Advanced Statistics under NEP 2020 based Ordinance OA-35 from the next academic year 2024-25. **(Action: Assistant Registrar Academic PG)**
D 3.12	**Minutes of the Board of Studies in History meeting held on 10.09.2023.** The Academic Council approved the minutes of the meeting of the Board of Studies in History held on 10.09.2023 recommending the Panel of Examiners for the B.A, B.Ed. Programme.

X AC- 14
13.10.2023

GOA UNIVERSITY
Taleigao Plateau, Goa 403 206

F I N A L A G E N D A

For the 14th Meeting of the

X ACADEMIC COUNCIL

Day & Date

Friday, 13th October 2023

Time

10.00 a.m.

Venue
Conference Hall
Administrative Block
Goa University

	i. Recommendations of the text books for the course of study at undergraduate level: Placed References for each course ii. Recommendations of the text books for the course of study at post graduate level: Placed References for each course **Part F.** Important points for consideration/approval of Academic Council i. The important points/recommendations of BoS that require consideration/ approval of Academic Council (points to be highlighted) as mentioned below - - Computer Organization Major Course of FY Computer Science to be repeated in the 3rd Semester as an optional Minor course under UG Computer Applications. This is to enable UG Computer Science students to opt for it in case they had not opted for it in first Semester. - Research Methodology Course suggested as a Major course for Computer Science and Computer Applications in fourth year in place of Seminar course as Seminar Course was not approved by the academic council. - Request for considering minor changes in Elementary Mathematics Course to cater to Non-Mathematics students and rename it as Basic Mathematics for the UG Computer Applications programme. **Annexure III** **(Refer page No.95)** - Introduction to Quantum Computing option to be provided as additional minor course in the fourth year for both UG honors in Computer Science and Computer Applications. - Syllabus for course on Data Analytics which is open for all **Annexure VII** **(Refer page No. 135)** - Request for incorporating minor corrections to Cyber Security Course. **Annexure VIII** **(Refer page No. 140)** ii. The declaration by the Chairperson that the minutes were readout by the Chairperson at the meeting itself Date: 25.07.2023 Sd/- Place: Goa University (Prof. Jyoti Pawar) Chairperson, Board of Studies **Part G**. The Remarks of the Dean of the Faculty i. The minutes are in order and may be placed before the Academic Council and may be recommended for approval of Academic Council. ii. Special remarks if any – Date: 25.07.2023 Sd/- Place: Goa University (Prof. Jyoti Pawar) Dean, Goa Business School **(Back to Index)**
D 3.10	**Minutes of the Board of Studies in Data Science meeting held on 02.08.2023.** **Part A**. i. Recommendations regarding courses of study in the subject or group of subjects at the undergraduate level:

- The Programme Structure and Syllabus for MSc Integrated Computer Science, Economics, and Decision Sciences for the batches already admitted under the old credit system (1 credit – 12 hours).
- The VI Semester Dissertation/Project Guidelines for MSc Integrated
- Under the NEP implementation for next batch 2024-25 onwards, Major courses to be from Computer Science / Data Science as the student is awarded BSc(Data Science) if he/she exits at the end of three years and Minor Courses to be from Economics / Management Studies / Mathematics, Multidisciplinary from Statistics / Economics / Management Studies, Skill Enhancement Courses to be Lab Courses till the V Semester. From VI Semester onwards, the Major courses will be from the specialization opted – Computer Science / Data Science / Decision Sciences / Economics. This is to be discussed in Academic Council for feedback/suggestions and the structure, syllabus to be finalized by the new BOS which is being constituted.

ii. Recommendations regarding courses of study in the subject or group of subjects at the postgraduate level: NIL

Part B

i. Scheme of Examinations at undergraduate level:
   - The VI Semester Dissertation/Project Guidelines for MSc Integrated (**Annexure IV Refer page No.231)**

ii. Panel of examiners for different examinations at the undergraduate level: NONE
iii. Scheme of Examinations at postgraduate level: NIL
iv. Panel of examiners for different examinations at post-graduate level: NONE

Part C.

i. Recommendations regarding preparation and publication of selection of reading material in the subject or group of subjects and the names of the persons recommended for appointment to make the selection: NIL

Part D

i. Recommendations regarding general academic requirements in the Departments of University or affiliated colleges: NIL
ii. Recommendations of the Academic Audit Committee and status thereof: As per University existing guidelines applicable for all programmes

Part E

i. Recommendations of the text books for the course of study at undergraduate level: Placed References for each course
ii. Recommendations of the text books for the course of study at post graduate level: Placed References for each course

Part F. Important points for consideration/approval of Academic Council

i. The important points/recommendations of BoS that require consideration / approval of Academic Council (points to be highlighted) as mentioned below -

	The Programme Structure and Syllabus for MSc Integrated Computer Science (Annexure I), **Refer page No.143** Economics (Annexure II **Refer page No.185)** and Decision Sciences (Annexure III **Refer page No.210)** for the batches already admitted under the old credit system. ii. The declaration by the Chairperson that the minutes were readout by the Chairperson at the meeting itself Date: 02.08.2023 Sd/- Place: Goa University (Prof. Jyoti Pawar) Chairperson, Board of Studies **Part G**. The Remarks of the Dean of the Faculty i. The minutes are in order and may be placed before the Academic Council and may be recommended for approval of Academic Council. ii. Special remarks if any – Date: 02.08.2023 Sd/- Place: Goa University (Prof. Jyoti Pawar) Dean, Goa Business School (Back to Index)
D 5	**STATUTES AND ORDINANCES**
D 5.1	**Proposed amendment to Statute SA-17(1) & (2) (xiv).** As per the resolution of the Executive Council meeting held on 26/05/2023, the Executive Council approved the proposal of shifting disciplines of Women Studies, Social Work and Public Administration under D. D. Kosambi School of Social Sciences and Behavioural Studies and Library and discipline of Information Science under the Goa Business School in Principle. The proposed amendment to Statute SA-17 (1) & (2) (xiv) was placed before the Drafting and Vetting Committee meeting held on 03/07/2023. The Drafting and Vetting Committee has vetted the said amendment, copy annexed as Annexure I **(Refer page No. 233)** The same is placed before the Academic Council for ratification. (Back to Index)
D 5.2	**Proposed Part Amendment to Ordinance OC-19 relating to the Post-graduate Degree in the Faculty of Medicine (Para Clinical, Pre Clinical and Clinical (Under Section 24 (1) of Goa University Act 1984)** The Dean, Goa Medical College & Faculty of the Medicine has informed vide letter No Acad/175/PG/GMC/2023/289 dated 28.06.2023 that the National Medical Commission (NMC), Medical Assessment & Rating Board (MARB), New Delhi has granted permission to Goa Medical College to start the following two Programmes for the Academic year 2023-2024. a) Doctor of Medicine (Geriatrics) (M.D.) b) Doctor of Medicine (Immunology Haematology and Blood Transfusion) (M.D.)

D 3.10 Minutes of the Board of Studies in Data Science meeting held on 02.08.2023.

Annexure I

M.Sc Integrated (Data Science / Decision Science / Computer Science / Economics) **Semester VI onwards specific to the Discipline Computer Science for students opting for MSc Integrated (Computer Science)**			
Semester I	**Credits**	**Semester II**	**Credits**
Same as M.Sc Integrated (Data Science)	22	**Same as M.Sc Integrated (Data Science)**	22
Semester III	**Credits**	**Semester IV**	**Credits**
Same as M.Sc Integrated (Data Science)	22	**Same as M.Sc Integrated (Data Science)**	22
Semester V	**Credits**	**Semester VI (Discipline:- Computer Science)**	**Credits**
Same as M.Sc Integrated (Data Science)	26	IMC- 603: Computer Networks	6
		IMC- 604: Software Engineering	6
		Elective 1: anyone to be opted from Data Science - IMC- 610 / IMC- 611 / IMC- 710 to IMC- 717	4
		Elective 2: anyone to be opted from Data Science -IMC-610 / IMC- 611 / IMC- 710 to IMC- 717	4
		IMC- 651: **Project Work** OR IMC- 652: **Internship**	6
Semester VII (Discipline:- Computer Science)	**Credits**	**Semester VIII(Discipline:- Computer Science)**	**Credits**
IMC- 703: Deep Learning	6	IMC- 803: MLOps at scale	6
IMC- 704: Design thinking for Data Driven App development	4	IMC- 804: Introduction to Quantum Computing	4
IMC- 705: Cloud Computing	6	IMC- 805: Fundamentals of IoT and Applications	6
IMC- 706: Formal Language and Automata Theory	4	**Elective 4**: anyone to be opted from Data Science – IMC- 710 to IMC- 717 or IMC- 910 to IMC-915	4
Elective 3: anyone to be opted from Data Science – IMC- 710 to IMC- 717 or IMC- 910 to IMC-915	4	**Elective 5**: anyone to be opted from Data Science – IMC- 710 to IMC- 717 or IMC- 910 to IMC-915	4
	24		24

Semester IX (Discipline:- Computer Science)	Credits	Semester X (Discipline:- Computer Science)	Credits
Elective 6: anyone to be opted from Data Science - IMC- 710 to IMC- 717 or IMC- 910 to IMC- 915	6	IMC- 1051: Dissertation **OR** IMC- 1052: Internship	16
Elective 7: anyone to be opted from Data Science - IMC- 710 to IMC- 717 or IMC- 910 to IMC- 915	6		
Elective 8: anyone to be opted from Data Science - IMC- 710 to IMC- 717 or IMC- 910 to IMC- 915	4		
	16		16
Total Credits (5 years) = *220*			

(Back to Index) (Back to Agenda)

Programme: MSc(Integrated) Computer Science
Course Code: IMC-603 **Title of Course:** Computer Networks
Number of Credits: 6(4L-0T-2P) **Contact Hours:** 96 hours (48L-0T-48P)
Effective from AY:2023-24

Prerequisites for the course	Computer Organization and Architecture	
Objectives	This course aims to – • Provide a foundation in computer networks, covering core concepts, protocols, configurations, and security. • Develop practical expertise in network analysis using Wireshark and network simulation using NS2.	
Content	Unit I: Review of Computer Networks, Devices, and the Internet: Internet, Network edge, Network core, Access Networks and Physical media, ISPs and Internet Backbones, Delay and Loss in Packet-Switched Networks, Networking and Internet - Foundation of Networking Protocols: OSI Model, TCP/IP Model, Internet Protocols and Addressing.	12 hours
	Unit II: The Link Layer and Local Area Networks-Link Layer, Introduction and Services, Error- Detection and Error-Correction techniques, Multiple Access Protocols, Link Layer Addressing, Ethernet, Interconnections: Hubs and Switches, Wireless LAN, and Bluetooth	12 hours

	Unit III: Network Layer: Introduction to the Network Layer and its functionalities. Logical addressing, IPV4 addressing basics and Header format, CIDR, sub-netting and sub-masking Routing algorithms: shortest path routing, Flooding, Hierarchical routing, Broadcast, Multicast, distance vector routing, Congestion Control Algorithms, Quality of Service	12 hours
	Unit IV: Transport Layer: Transport Services, Elements of Transport protocols, Connection management, TCP and UDP protocols. Application Layer: the World WEB, HTTP, Domain name system, Electronic Mail; Understand network security concepts: encryption, authentication, firewalls. Introduction to wireless communication fundamentals. Overview of mobile network. wireless LANs and mobile IP.	12 hours
Lab/Practical Component	Part A: 1. Usage of commands like tcpdump, netstat, ifconfig, nslookup and traceroute. 2. Capture ping and traceroute PDUs using a network protocol analyzer. 3. Writing Wireshark filter expressions for packet capture 4. Using ping for RTT distribution and tracert for route discovery	4 * 4 = 16 hours
	Part B: Study of Network simulator (ns2) and Simulation of Routing protocols and Congestion Control Algorithms. Suggested list of experiments: 1. Implement a point-to-point network with four nodes and duplex links between them. Analyze the network performance by setting the queue size and varying the bandwidth. 2. Implement a four node point to point network with links n0-n2, nl-n2 and n2-n3. Apply TCP agent between n0-n3 and UDP between nl-n3. Apply relevant applications over TCP and UDP agents changing the parameter and determine the number of packets sent by TCP/UDP. 3. Implement Ethernet LAN using n (6-10) nodes. Compare the throughput by changing the error rate and data rate. 4. Implement Ethernet LAN using n nodes and assign multiple traffic to the nodes and obtain congestion window for different sources/ destinations. 5. Implementation of distance vector routing algorithm	6 * 4 = 24 hours

	6. Implementation of Link state routing algorithm	
	Part C: A Mini Project	12 hours
Pedagogy	• Lecture/tutorial/Assignemnt/ discussions/peer-teaching / flip classroom. • Programming assignments/ discussions/ self-review/ peer-review/ testing of code/ debugging of code/ projects	
References/ Readings	1. Forouzan, Behrouz A. Data Communications and Networking with TCP/IP Protocol Suite. McGraw-Hill US Higher Ed USE, 2021. 2. Kurose, Keith Ross. "Computer networking: A top-down approach" Kurose, Keith W. Ross.(2017): 601. 3. Wireshark manual available at: https://www.wireshark.org/docs/wsug_html_chunked/ 4. ns2 manual: https://www.isi.edu/nsnam/ns/doc/index.html	
Learning Outcomes	After completing the course students will be able to • explain the importance of computer networks, describe network models, and identify critical components of a network. • understand IP addressing and basic routing, analyze transport layer functions, and configure application services. • to discuss network security measures, and understand wireless communication. Analyze network traffic, and protocols using Wireshark. • Design, simulate, and evaluate network scenarios using NS2, Interpret performance metrics and mobility models.	

(Back to Index) (Back to Agenda)

Programme: MSc(Integrated) Computer Science
Course Code: IMC-604 **Title of Course:** Software Engineering
Number of Credits: 4 (4L-0T-2P) **Contact Hours:** 96 hours (48L-0T-48P)
Effective from AY:2023-24

Prerequisites for the course	Knowledge of programming, and hands-on experience with object oriented and web application development	
Objectives	This course will enable the learner to work in the software development ecosystem with tools and in team with a stress on how to adopt them in various activities and techniques	
Content (theory)	SDLC, Design Patterns • Software development processes and methodologies: Waterfall, agile methodologies, etc • Reusability at design level. Principles of good design. Creational,	12 hours

	structural and behavioral patterns. • Refactoring to patterns-(Decorators, Observer and Factory Pattern).	
	Project Management, TDD and Refactoring • Project planning and monitoring. Team management. Retrospectives. • User story, estimation using user story, sprint planning, burndown chart. • TDD, Refactoring exercises(IDE Refactoring), Code smells. • Debugging: principles, approaches, use of debuggers	12 hours
	Testing & Profiling • Integration testing, GUI testing etc • Automatic testing (desktop/web-selenium/mobile) • Alpha and beta testing • Defect tracking, bugzilla • Testing Frameworks & BDD (TestNG, JBehave, Cucumber)	12 hours
	Code analysis, profiling and CI/CD: • Static code analysis tools (GProf, Sonar) • Build management & Dependency tools (Maven/Ant/Gradle/npm) • Source code and version control (Git and subversion), change control procedure, pull requests, fork & branches, conflict resolution • Containerization and orchestration, Travis, YAML	12 hours
	Suggested Lab work (48 hours): 1. Design Patterns: Assignment-1 2. Design Patterns: Assignment-2 3. Assignment to debug and remove code smells by refactoring (use a static code analysis tool) 4. Assignment to create and execute automated tests 5. Assignment to configure and build software project (use of a build tool) to add dependencies 6. Assignment using containerization (e.g. Docker) 7. Assignment for orchestration of containers (e.g. Kubernetes) 8. Assignment to build and deploy code using CI/CD pipeline (e.g travis/yaml) 9. Mini Project: create a software application using concepts learnt in this course and follow the process for project monitoring	32 (4hrs x 8) + 16 hrs (Mini Project)
Pedagogy	Hands-on assignments / tutorials / peer-learning / project	
References/ Readings	1. Martin Fowler, —Refactoring, Pearson Education, 2nd Edition, 2019 2. Erich Gamma, Richard Helm, Ralph Johnson, John Vlissides, Design Patterns: Elements of Reusable Object-oriented Software, Pearson Education. 3. Joshua Kareivesky, — Refactoring to Patterns, Pearson Education 4. Steve McConnell, — Code Complete, 2nd Edition. Redmond, W., Microsoft Press, 2004 5. Chris Sims and Hillary Louise Johnson —The Elements of Scrum, 2011 6. Rachel Davies, Liz Sedley —Agile Coaching, Pragmatic Bookshelf, 2009	

	7. Venkat Subramaniam, Andrew Hunt —Practices of an Agile Developer, Pragmatic Bookshelf, 2006 8. Dorothy Graham, Rex Black, Erik van Veenendaal, Foundations of Software Testing ISTQB Certification	
Course Outcomes	1. Learner will gain insights and skills of the end-to-end project management for software engineering/development 2. Learner will be able to design, and develop complete software architecture and solution 3. Learner will be able to build and deploy code pipelines into multiple software environments 4. Learner will be gains skills required by a software Quality Assurance (Testing) personnel	

(Back to Index) (Back to Agenda)

Programme: MSc(Integrated) Computer Science **and** MSc(Integrated) Data Science
Course Code: IMC- 703 **Title of the Course:** Deep Learning
Number of Credits: 6(4L-0T-2P) **Contact hours:** 96 hours (48L-0T-48P)
Effective from AY: 2022-23

Prerequisites for the course	Machine Learning, Programming, Probability and Statistics, Linear Algebra	
Objectives	To study the basics of Neural Networks and their various variants such as the Convolutional Neural Networks and Recurrent Neural Networks, to study the different ways in which they can be used to solve problems in various domains such as Computer Vision, Speech and NLP.	
Content Theory	Moving beyond Linearity-Non-Linear regression-polynomial and spline-polynomial regression, step function, basis function, regression splines - piecewise polynomials, constraints and splines, the spline basis representation, etc - smoothing splines, Generalized additive models History of Deep Learning, McCulloch Pitts Neuron, Thresholding Logic, Perception Learning Algorithm and Convergence. Multilayer Perceptions (MLPs), Representation Power of MLPs, Sigmoid Neurons, Gradient Descent. Feed forward Neural Networks, Representation Power of Feed forward Neural Networks, Back propagation. Gradient Descent (GD), Momentum Based GD, Nesterov Accelerated GD, Stochastic GD, Adagrad, AdaDelta,RMSProp, Adam,AdaMax,NAdam, learning rate schedulers. Auto encoders and relation to PCA, Regularization in autoencoders, Denoising autoencoders, Sparse autoencoders, Contractive autoencoders. Bias Variance Tradeoff, L2 regularization, Early stopping, Dataset augmentation, Parameter sharing and tying, Injecting noise at input, Ensemble methods, Dropout Greedy Layer Wise Pre-training, Better activation functions, Better weight initialization methods, Batch Normalization. Learning Vectorial Representations Of Words, Convolutional Neural Networks, LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet. Visualizing Convolutional Neural Networks, Guided Backpropagation, Deep Dream, Deep Art,	4 hours 8 hours 12 hours 12 hours 12 hours

	Fooling Convolutional Neural Networks. Recurrent Neural Networks, Backpropagation Through Time (BPTT), Vanishing and Exploding Gradients, Truncated BPTT. Gated Recurrent Units (GRUs), Long Short Term Memory (LSTM) Cells, Solving the vanishing gradient problem with LSTM. Encoder Decoder Models, Attention Mechanism, Attention over images, Hierarchical Attention, Transformers.	
Content Practical	**Suggested Lab Assignments** 1. Data representation for neural networks . 2. The gears of neural networks -Tensor operations. 3. Engine of neural network – implementation of gradient -based optimization algorithm. 4. Getting started with keras- setting up a deep learning workstation. 5. Writing program to classify movie reviews-binary classification example. 6. Classifying newswires -multi classification example 7. Predicting house prices-regression example 8. Program to understand the effect of under fitting and over fitting. 9. Training a Convent on a small dataset. 10. Learning to use predefined convent. 11. Sequencing processing example using recurrent network and LSTM 12. Generative deep learning assignment-Text generations with LSTM	12 * 4 = 48 hours
Pedagogy	Lectures/ Tutorials/Hands-on assignments/Self-study	
References/ Readings	1. Ian Goodfellow and YoshuaBengio and Aaron Courville. Deep Learning. An MIT Press book. 2016. 2. Charu C. Aggarwal. Neural Networks and Deep Learning: A Textbook. Springer. 2019. 3. Deep Learning with Python by Francois Chollet, 2017 4. Deep Learning from scratch by ActhEidman, O'Reilly Publication , 2019. 5. Deep learning with PyTorch by Eli Stevens, Luca Antiga, Thomas,2020.	
Course Outcomes	1. Understand deep learning fundamentals. 2. Develop and train deep learning models. 3. Apply deep learning to real-world problems. 4. Evaluate and optimize deep learning models.	

(Back to Index) (Back to Agenda)

Programme: MSc(Integrated) Computer Science **and** MSc(Integrated) Data Science
Course Code: IMC- 704 **Title of the Course:** Design Thinking for Data-Driven App Development
Number of Credits: 4(4L-0T-0P) **Contact hours:** 48 hours(48L-0T-0P)
Effective from AY: 2022-23

Prerequisites for the course	None	
Objectives	This course helps you learn the basics of Design Thinking in an experiential way. This course aims at an empathy-led data-driven app development	

	approach for data scientists. The learners will launch a fully functioning app in a real app store at the end of the course.	
Content	Introduction to Design Thinking – Course outline and projects, Intro to the Design of Everyday Things, Intro to Design Thinking in software apps, Project management. Empathize phase (Iteration #1)-- Emotional and intellectual map of the user stories from interviews, User story creation and Customer Journey Mapping Analyze phase (Iteration #1) - Stated needs and unsaid/latent needs, Root cause analysis, Multiple perspectives of customers and manufacturers, Frame conflicts from popular movies. Solve phase (Iteration #1)Structured and unstructured creativity, Dynamics of group thinking, Optimal conditions of creativity, Natural creativity, Concept creation via group activities, Silent brainstorming, inventive principles and concept consolidation Test phase (Iteration #1)/ Empathize phase (Iteration #2) - Basics of prototyping, Assumptions in creation of new concepts, Features rather than ideas. Basics of Digital Marketing, User Experience Design, Website Development Analyze phase (Iteration #2) Solve phase (Iteration #2) - Introduced problems via the solution from iteration #1, the subsequent ideation process in iteration #2, apply solutioning and analysis tools in iteration #2, subsequent testing and field trial skills required for iteration #3, analytical tools and data oriented tools on iteration #3. Test (Iteration #2) / Empathize (Iteration #3) - Basics of obtaining insights from feedback from a live audience. Analyze (Iteration #3). Test phase (Iteration #3) - Launch of the App.	12 hours 12 hours 12 hours 12 hours
Pedagogy	Hands-on assignments / Tutorials / Peer-teaching /Presentations	
References/ Readings	1. Design of everyday things by Don A. Norman, 2013. 2. This is Service Design thinking- basics, tools and cases by Marc Stickdorn, 1st edition,John Wiley & Sons Inc,2012.	
Course Outcomes	1. Recall the basics of Design Thinking and Apply Agile method to developing software 2. Design an App using the principles of Design Thinking 3. Develop an App for Android and Collaborate with other developers using git version control method 4. Learn the basics of marketing and customer support through their website	

Programme: MSc(Integrated) Computer Science
Course Code: IMC-705 **Title of Course:** Cloud computing
Number of Credits: 4 (4L-0T-2P) **Contact Hours:** 96 hours (48L-0T-48P)
Effective from AY:2023-24

Prerequisites for the course	Computer Networks, Operating Systems, Data Structures and Algorithms	

Objectives	To learn the design and development process involved in creating a cloud-based application	
Content	Unit I: Introduction to Cloud Computing Understanding cloud computing components Exploring cloud infrastructure and its services Overview of cloud storage and database services Cloud deployment models: public, private, hybrid Overview of services offered by cloud platforms: IaaS, PaaS, SaaS Cloud Security Principles and Services	12 hours
	Unit II: Fundamentals of Virtualization, different types of virtualization: server, desktop, memory, application, and storage Tools and Products Available for Virtualization. Introduction to Docker containers and their benefits.	12 hours
	Unit III: Introduction to SaaS and PaaS: Understanding the multitenant nature of SaaS solutions, OpenSaaS solutions, principles of Service-Oriented Architecture (SOA) PaaS- Benefits and Limitations of PaaS. Security as a Service	12 hours
	Unit IV: IaaS and cloud data storage: Understanding IaaS, Improving performance through Load balancing, Server Types within IaaS solutions, Utilizing cloud-based NAS devices, Cloud based data storage, Cloud based database solutions, Cloud based block storage. Cloud Applications and security: Open Source and Commercial Clouds, Cloud Simulators, Research trends in Cloud Computing, Fog Computing and applications, Cloud Security challenges.	12 hours
Lab/Practical Component	1. Find a procedure to run the virtual machine of different configurations. Check how many virtual machines can be utilized at a particular time. 2. Find the procedure to attach a virtual block to the virtual machine and check whether it holds the data even after the release of the virtual machine. 3. Install a C compiler in the virtual machine and execute a sample program. 4. Installing Google App Engine. Create Hello World app and other simple web applications using Python/Java. 5. Hosting a static website on the Google app engine 6. Use the GAE launcher to launch the web applications. 7. Find the procedure to set up the one-node Hadoop cluster	10 * 3 = 30 hours

	8. Mount the one-node Hadoop cluster using FUSE. 9. Write a program to use the APIs of Hadoop to interact with it. 10. Write a wordcount program to demonstrate the use of Map and Reduce tasks A Miniproject	18 hours
Pedagogy	• Lecture/tutorial/Assignemnt/ discussions/peer-teaching / flip classroom. • Programming assignments/ discussions/ self-review/ peer-review/ testing of code/ debugging of code/ projects	
References/ Readings	1. R. Buyya, C. Vecchiola, S T. Selvi, Mastering Cloud Computing, McGraw Hill (India) Pvt Ltd., 2013 2. Kris Jamsa, Cloud Computing: SaaS, PaaS, IaaS, "Virtualization, Business Models, Mobile, Security and more, Jones & Bartlett Learning Company, 2013 3. White, Tom. Hadoop: The definitive guide. " O'Reilly Media, Inc.", 2012. 4. VMWare documentation: https://docs.vmware.com/ 5. Hadoop documentation: https://hadoop.apache.org/docs/stable/	
Learning Outcomes	After completing the course students will be able to ● differentiate between cloud service models (IaaS, PaaS, SaaS). ● employ various cloud-based data storage solutions, such as NAS devices, databases, and block storage, to efficiently manage and store data in cloud environments. ● Understand IaaS including load balancing and server types. ● Configure various virtualization tools such as Virtual Box, and VMware workstation. ● Design and deploy a web application in a PaaS environment.	

(Back to Index) (Back to Agenda)

Programme: MSc(Integrated) Computer Science
Course Code: IMC-706 **Title of Course:** Formal Language and Automata Theory
Number of Credits: 4 (4L-0T-0P) **Contact Hours:** 48 hours (48L-0T-0P)
Effective from AY:2023-24

Prerequisites for the course	Nil	
Objectives	To provide students with an understanding of formal languages, automata theory, and their applications in the field of theoretical computer science.	

Content	General Concepts of Automata Theory: Alphabets Strings, Languages, Grammars, Applications of Automata Theory. Finite Automata (FA): Introduction, Deterministic Finite Automata (DFA) - definition and notations, the language of a DFA. Nondeterministic Finite Automata (NFA)- Definition, language of an NFA, Equivalence of DFA and NFA, Applications of FA. Finite Automata with Epsilon Transitions, Eliminating Epsilon Transitions, Minimization of DFA. Finite automata with output (Moore and Mealy machines) and inter-conversion.	12 hours
	Regular Expressions (RE): Introduction, Identities of RE. Finite Automata and Regular Expressions - conversions, Algebraic Laws for Regular Expressions, applications of RE. Regular grammars: Definition, regular grammars, and FA, Proving languages to be non-regular (Pumping lemma), Properties of Regular Language, applications.	12 hours
	Pushdown Automata (PDA): Definition, Language of PDA- Acceptance by Final State and Acceptance by Empty stack, Equivalence of CFG and PDA, Deterministic PDA, Chmosky normal form of CFG Turing Machines (TM): Formal definition and behavior, Languages of a TM, TM as accepters, and TM as a computer of integer functions, Types of TMs.	12 hours
	Recursive And Recursively Enumerable Languages (REL): Properties of recursive and recursively enumerable languages, Universal Turing machine, The Halting problem, Undecidable problems about TMs. Context-sensitive language and linear bounded automata (LBA), Chomsky hierarchy, Decidability.	12 hours
Pedagogy	lectures/ tutorials/assignments/self-study	
References/ Readings	1. Hopcroft, John E., Rajeev Motwani, and Jeffrey D. Ullman. "Automata theory, languages, and computation." International Edition 24.2 (2006): 171-183. 2. Lewis, Harry R., and Christos H. Papadimitriou. "Elements of the Theory of Computation." ACM SIGACT News 29.3 (1998): 62-78. 3. Martin, John C. Introduction to Languages and the Theory of Computation. Vol. 4. NY: McGraw-Hill, 1991.	
Learning Outcomes	At the end of the course, students will be able to: ● To use basic concepts of formal languages of finite automata techniques ● To design Finite Automata for different Regular Expressions and	

	Languages ● To Construct context-free grammar for various languages ● Explain the Chomsky hierarchy and the relationship between different classes of formal languages.	

(Back to Index) (Back to Agenda)

Programme: MSc(Integrated) Computer Science **and** MSc(Integrated) Data Science
Course Code: IMC- 803 **Title of the Course:** MLOps At Scale
Number of Credits: 6(4L-0T-2P) **Contact hours:** 96 hours(48L-0T-48P**)**
Effective from AY: 2022-23

Prerequisites for the course	Familiarity with linear algebra, probability theory, machine learning , familiarity with python.	
Objectives	This course is aimed at anyone who wishes to explore deep learning from scratch. This course offers a practical hands on exploration of deep learning, avoiding mathematical notation, preferring instead to explain quantitative concepts through programming using python API	
Content Theory:	Introduction to MLOps Rise of the Machine Learning Engineer and MLOps-What Is MLOps?-DevOps and MLOps-An MLOps Hierarchy of Needs-Implementing DevOps-Configuring-Continuous Integration with GitHub Actions-DataOps and Data Engineering-Platform Automation-MLOps	3 hours
	MLOps Foundations-Bash and the Linux Command Line-Cloud Shell Development Environments-Bash Shell and Commands-List Files Run CommandsFiles and Navigation-Input/Output-Configuration-Writing a Script-Cloud Computing Foundations and Building Blocks-Getting Started with Cloud Computing- minimalistic python revision-Descriptive Statistics and Normal Distributions-Optimization-Machine Learning Key Concepts-Doing Data Science-Build an MLOps Pipeline from Zero	5 hours
	MLOps for Containers and Edge Devices Containers-Container Runtime-Creating a Container Running a Container-Best Practices-Serving a Trained Model Over HTTP-Edge Devices-Coral Azure Percept-TFHub-Porting Over Non-TPU Models-Containers for Managed ML Systems-Containers in Monetizing MLOps-Build Once, Run Many MLOps Workflow	5 hours
	Continuous Delivery for Machine Learning Models-Packaging for ML Models-Infrastructure as Code for Continuous Delivery of ML Models-Using Cloud Pipelines-Controlled Rollout of Models-Testing Techniques for Model Deployment	5 hours
	AutoML and KaizenML-AutoML-MLOps Industrial Revolution-Kaizen Versus KaizenML-Feature Stores-Apple's Ecosystem-Apple's AutoML: Create ML-Apple's Core ML Tools orGoogle'sAutoML and Edge Computer Vision or Azure's AutoMLor AWS AutoML-Open Source AutoML Solutions-Ludwig-FLAML-Model Explainability	5 hours
	Monitoring and Logging-Observability for Cloud MLOps-Introduction to Logging-Logging in Python-Modifying Log Levels-Logging Different Applications-Monitoring and Observability-Basics of Model Monitoring-	5 hours

	Monitoring Drift with AWS SageMaker-Monitoring Drift with Azure ML MLOps for AWS-Introduction to AWS-Getting Started with AWS Services-MLOps on AWS-MLOps Cookbook on AWS-CLI Tools-Flask Microservice-AWS Lambda Recipes-AWS Lambda-SAM Local-AWS Lambda-SAM Containerized Deploy-Applying AWS Machine Learning to the Real World	5 hours
	Machine Learning Interoperability-Why Interoperability Is Critical-ONNX: Open Neural Network Exchange-ONNX Model Zoo-Convert PyTorch into ONNX -Convert TensorFlow into ONNX-Deploy ONNX to Azure-Apple Core ML-Edge Integration.	5 hours
	Building MLOps Command Line Tools and Microservices-Python Packaging-The Requirements File-Command Line Tools-Creating a Dataset Linter Modularizing a Command Line Tool-Microservices-Creating a Serverless Function-Authenticating to Cloud Functions-Building a Cloud-Based CLI-Machine Learning CLI Workflows	5 hours
	Machine Learning Engineering and MLOps Case StudiesUnlikely Benefits of Ignorance in Building Machine Learning Models-MLOps Projects at Sqor Sports Social Network-Mechanical Turk Data Labeling-Influencer Rank-Athlete intelligence (AI product)-The perfect techniques versus the real world-critical challenges in MLops- Ethical and unintended consequences-lack of operational excellences- focus on prediction accuracy vs the big picture	5 hours
Content Practical:	Machine Learning in Production • A journey through Data • Data Labelling Machine Learning Data Lifecycle in Production • TFDV Exercise • Data Validation • Simple Feature Engineering • Feature Engineering Pipeline • Feature Selection • ML Metadata • Iterative Schema • Data Pipeline Components for Production ML • Feature Engineering with Weather Data • Feature Engineering with Accelerometer Data • Feature Engineering with Images Machine Learning Modeling Pipelines in Production • Intro to Keras Tuner • Hyperparameter tuning and model training with TFX • Manual Dimensionality • Algorithmic_Dimensionality • Quantization and Pruning • TensorFlow Model Analysis • Model Analysis with TFX Evaluator • Fairness Indicators	12 hours 12 hours 12 hours

	• Shapley Values • Permutation Feature Importance Deploying Machine Learning Models in Production • Intro to Docker and installation -First look at Tensorflow Serving with Docker -Serve a model with TensorFlow Serving • Intro to KFP • TFX Custom Components • TFS Model Versioning • Github Actions	12 hours
Pedagogy	Lectures/ tutorials/lab assignments/self-study	
References/ Readings	Main Reading :- 1. Practical MLops – Noah Gift and AlfredoDeza,O'Reilly Media, Inc, 2021. 2. Introduction to MLOps – Noah Gift and AlfredoDeza, Pragmatic AI Solutions, 2021.	
Course Outcomes	1. Understand What Is MLOps and MLOps Foundations 2. Continuous Delivery for Machine Learning and Monitoring and Logging 3. MLOps for AWS-Introduction 4. Machine Learning Interoperability and Machine Learning Engineering	

(Back to Index) (Back to Agenda)

Name of the Programme: MSc Integrated (Computer Science)
Course Code: IMC-804 **Title of the Course:** Introduction to Quantum Computing
Number of Credits: 4T **Number of Hours:** 48
Effective from AY: 2023-24

Pre-requisites for the Course:	Basic Knowledge of Boolean Algebra, Data Structures, Theory of Computation, Computational Complexity, Error Corrections, & Algorithm Analysis	
Course Description	The feasibility of quantum computers remains uncertain, but if they become a reality, they will revolutionize computational methods and have profound effects on various applications, including communication and computer security. Despite the uncertainty, it is still fascinating to explore the principles of quantum computing.	
Course Objectives:	1. To introduce students to the fast-growing field of quantum computing 2. To create an understanding of the differences between quantum bits and classical bits 3. To familiarize with the basic quantum logical operations and algorithms 4. To provide an initial overview of quantum computing, emphasizing the shift in paradigm from classical computing and introducing fundamental quantum algorithms. 5. To equip students with future-proof skills, enable them to tackle complex problems, enhance critical thinking abilities, and promote interdisciplinary learning.	
Unit	**Content**	**Duration (Hours)**

1	Introduction to Quantum Computing One Quantum Bit • Superposition- superposition, complex numbers • Measurement- measurement in Z-basis, normalization, measurement on other basis, consecutive measurements • Bloch Sphere Mapping- global and relative phases, Bloch sphere • Physical qubits • Quantum Gates- linear maps, classical reversible gates, common one-qubit quantum gates, General one-qubit gates • Quantum Circuits Linear Algebra • Quantum States- Column and row vectors • Inner Products- Inner products, Orthonormality, Projection, Measurement, Change of basis • Quantum Gates- Gates as matrices, Common one-qubit gates as matrices, sequential quantum gates, Circuit identities, Unitarity, Reversibility	12
2	Multiple Quantum Bits • States and Measurement- Tensor product, Kronecker product, Measuring individual qubits, sequential single-qubit measurements • Entanglement- Product states, Entangled states • Quantum Gates- One-qubit quantum gates, Two-qubit quantum gates, Toffoli gate • No-cloning theorem • Quantum Adders- Classical adders, Converting classical adder to quantum gate, Quantum setup, Quantum sum, Quantum carry, Quantum ripple-carry adder, Circuit complexity, Adding in Superposition • Universal Quantum Gates- Definition, Components, Examples, Solovay-Kitaev theorem • Quantum Error Correction- Decoherence, Bit-flip code, Phase-flip code, Shor code	12
3	Entanglement and Quantum Protocol • Measurements- Product states, Maximally entangled states, Partially entangles states • Bell Inequalities- ERP paradox and local hidden variables, Bell inequalities and the CHSH inequality, Quantum processor experiment, No-signaling principle • Monogamy and Entanglement- Classical correlations, Quantum entanglement • Superdense Coding- The problem, Classical solution, Quantum solution • Quantum Teleportation- The problem, Classical solution, Quantum	12

	Solution • Quantum Key Distribution- Encryption, Classical solution: public key cryptography, Quantum solution: BB84	
4	Quantum Algorithms • Circuit vs Query Complexity- Circuit complexity, Query complexity, Quantum Oracles, Phase Oracle • Parity- The problem, Classical solution, Quantum solution: Deutsch's Algorithm • Constant vs Balanced Functions- The problem, Classical solution, Quantum solution: Deutsch-Jozsa Algorithm • Secret Dot Product String- The problem, Classical solution, Quantum solution: Bernstein-Vazirani Algorithm, Recursive problem • Secret XOR Mask: The problem, Classical solution, Quantum solution: Simon's Algorithm • Brute-Force Searching: The problem, Classical solution, Quantum solution: Grover's Algorithm, Reflection about uniform state, Optimality • Discrete Fourier Transform- Application: Analyzing music, Classical solution: Fast Fourier transform, Quantum solution: Quantum Fourier transform, Inverse quantum Fourier transform • Phase/Eigenvalue Estimation- The problem, Classical solution, Quantum solution, Multiple Eigenstates • 5.9 Factoring- The problem, Classical solution, Quantum solution: Shor's Algorithm	12
References	1. Nielsen, M. A. (2005). Cluster-state quantum computation. https://doi.org/10.1016/S0034-4877(06)80014-5 2. Quantum Computation and Quantum Information by Michael A. Nielsen & Isaac L. Chuang, 10th Anniversary Edition 3. Quantum Computing for Everyone by Chris Bernhardt 4. Dancing with Qubits- How quantum computing works and how it can change the World by Robert S. Sutor 5. Quantum Computing: An Applied Approach by Jack D. Hidary (Springer 2019) 6. Quantum Computing for Beginners: A Complete Beginner's Guide to Explain in Easy Way, History, Features, Developments and Applications of New Quantum Computers that will Revolutionize the World by Simon Edwards	
Course Outcomes	**On completion of the course, students will be able to –** 1. Understand the characteristics of classical and quantum computing systems 2. Describe systems with qubits 3. Perform basic quantum computing operations 4. Perform the quantum Fourier transform 5. Understand basic quantum algorithms	

(Back to Index) (Back to Agenda)

Programme: MSc(Integrated) Computer Science
Course Code: IMC-805 **Title of Course:** Fundamentals of IoT and Applications
Number of Credits: 6(4L-0T-2P) **Contact Hours:** 96 hours (48L-0T-48P)
Effective from AY:

Prerequisites for the course	Computer Organization and Architecture, Computer Networks, Cloud computing	
Objectives	• Gain a comprehensive understanding of Internet of Things (IoT) concepts, technologies, and applications. • Develop practical expertise in IoT technologies by designing, and building IoT systems, using sensors, communication protocols, and cloud services to create functional applications and projects.	
Content	Unit I: Introduction to IoT: Defining IoT, History of IoT, Importance of IoT, IoT Basic Characteristics, About Objects/things in the IoT, Enabling Technologies of IoT; About the Internet in IoT, IoT Advantages and Disadvantages; M2M Overview, M2M Features; M2M Ecosystem, Comparison of the Main Characteristics of M2M and IoT. IoT Architecture: Basic Building blocks of IoT system: Sensors, Processors, gateways, Applications Physical design of IoT: Things in IOT, IoT Protocols, Logical design of IoT: IoT Functional Blocks, IoT Communication Models. IoT Communication API's	12 hours
	Unit II: Wireless Technologies for IoT: WPAN Technologies for IoT: IEEE 802.15.4, Zigbee, HART, NFC, Z-Wave, BLE IP-Based Protocols for IoT IPv6, 6LowPAN, RPL, REST, AMPQ, CoAP, MQTT. Edge connectivity and protocols	12 hours
	Unit III: Data Handling& Analytics: Introduction, Bigdata, Types of data, Characteristics of Big data, Data handling Technologies, Flow of data, Data acquisition, Data Storage, Introduction to Hadoop. Introduction to data Analytics, Types of Data analytics, Local Analytics, Cloud analytics and applications	12 hours
	Unit IV: Applications of IoT: Home Automation, Smart Cities, Energy, Retail Management, Logistics, Agriculture, Health and Lifestyle, Industrial IoT,	12 hours

	Legal challenges, IoT design Ethics, IoT in Environmental Protection.	
Lab / Practical Component Details	Experiment 1: Introduction to IoT Devices Setting up and configuring an IoT development board (e.g., Arduino, Raspberry Pi). Blinking an LED as a basic introduction to controlling IoT devices. Experiment 2: Sensor Interfacing Interfacing temperature and humidity sensors with an IoT platform. Reading sensor data and displaying it on an LCD screen. Experiment 3: IoT Communication using MQTT Setting up an MQTT broker (e.g., Mosquitto) on a local machine. Publishing sensor data to MQTT topics and subscribing to receive data. Experiment 4: Cloud Data Storage Setting up a cloud service (e.g., Google Cloud IoT Core, AWS IoT Core) for data storage. Sending sensor data to the cloud using MQTT or RESTful APIs. Experiment 5: IoT Security Measures Implementing password protection for IoT devices. Encrypting data transmission over MQTT using SSL/TLS. Experiment 6: Edge Computing Setting up an edge computing environment on a Raspberry Pi. Processing sensor data locally and making simple decisions. Experiment 7: Real-time Data Visualization Creating a web-based dashboard to visualize real-time sensor data. Using platforms like ThingSpeak or Node-RED for data visualization. Mini-Project: IoT Project Development Collaboratively developing a comprehensive IoT project in groups.	For 7 Experiments 7 * 5 = 35 13 hours for mini project
Pedagogy	• Lecture/tutorial/Assignemnt/ discussions/peer-teaching / flip classroom. • Programming assignments/ discussions/ self-review/ peer-review/ testing of code/ debugging of code/ projects	
References/ Readings	1. Hanes, David, et al. IoT fundamentals: Networking technologies, protocols, and use cases for the Internet of things. Cisco Press, 2017. 2. Buyya, Rajkumar, and Amir Vahid Dastjerdi, eds. Internet of Things: Principles and paradigms. Elsevier, 2016.	

Learning Outcomes	After the completion of the course, students will be able to ● Define the Internet of Things (IoT) and its significance in the modern technological landscape. ● Identify key components of IoT ecosystems, including devices, connectivity, data processing, and applications. ● Recognize the significance of various communication protocols in IoT, such as MQTT and CoAP, and their role in efficient data transmission. ● Proficiently design, construct, and analyze Internet of Things (IoT) prototypes, apply sensor integration, use communication protocols ● Discuss real-world applications of IoT across various domains	

LIST OF ELECTIVE COURSES FROM MSC INTEGRATED DATA SCIENCE -

Programme: MSc Integrated
Course Code: IMC-610 **Title of Course:** Data Driven Web App Development
Number of Credits: 4 (2L-0T-2P **Contact hours:** 72 hours (24L-0T-48P)
Effective from AY: 2022-23

Prerequisites for the course	Knowledge of programming	
Objectives	The course will help the learner build websites and web applications.	
Content	**Foundation in Internet Technologies** • Basic concepts in Computer Networks; Protocols • Evolution of Internet and World Wide Web (WWW) • Web Architectures & Standards • Browsers & browser-engines	3 hours
	Web page design • HTML:- markup language; XML & HTML; tag & attributes; semantic (header, main, nav, etc.) & non-semantic elements (div, span); headings, paragraphs, text-formatting tags; colors & background; tables & lists; entities, charsets; links; iframe; form & input - attributes & elements; SVG & canvas • CSS:- syntax & selectors; box model; text & font properties; display, position, z-index; float & clear; styling for images & html form elements; 2-D/3-D transform, transition, animation; responsive, adaptive & mobile-first layout; viewport & media queries • CSS library/ framework (e.g. Bootstrap, Foundation)	5 hours
	Client-side scripting • Dynamic web pages • JavaScript:- programming features; events; functions; Manipulating DOM; Beyond ECMA 4 • Javascript library/ framework (e.g. JQuery, ReactJS)	4 hours
	HTTP & Middle-ware	4 hours

	• HTTP, Request & Response, methods & error code, • headers, URL encoding & decoding • XML, data & XPath • JSON	
	Server-side Programming • Server instance • Request handling & response creation • HTML forms & file uploads • Session management & application data • Database connectivity • AJAX • Introduction to a Server-side library and/or template engine and/or framework (e.g. PHP - Laravel; JSP - Spring)	4 hours
	Data-driven web pages • User Experience Fundamentals:- gulf of evaluation and execution; 7 fundamental & universal design principles; Design Elements (line, color, shape, form vs space, value, texture, dot, typography, movement); Visual Design Principles (scale, dominance/emphasis, balance, harmony); Wireframing, Mockup & Prototype (Paper & Digital); Use of tools (e.g. Pencil, Adobe XD, Sketch and/or Figma); Interaction & Animation • Use of any data visualization library (D3.js, Chart.js):- charts, graphs, maps, diagrams; SVG; scales & visuals for multi-device • Building UI for large forms, paginated tables, etc. • JSON API & AJAX; lazy loading	4 hours
	Suggested Lab Assignments (48 hours): 1. Web page design Assignments a. Create a website on a topic given by the instructor, evaluating the website with rubrics for good web design. b. Build a website using HTML & CSS by looking at a screenshot/picture of a website component given by the instructor. c. Websites built with tables, forms, images, iframes, etc. d. A website for each of design strategies (fixed, adaptive, responsive, fluid, mobile-first, etc.). e. Assignments using css pseudo-classes & -elements; grid & flex design; understanding the CSS box model & working with the browser developer tools; CSS transformations, transitions & animations f. Assignment to create a website built with Bootstrap based on a topic given by the instructor. 2. Client-side scripting Assignments a. An assignment for understanding the programming aspects of JavaScript and working with the browser developer tools. The use of the newer features of JavaScript (after ECMA 4) is encouraged.	4 * 10 = 40 + 8 (Mini Project)

	b. An assignment working with regular expressions. A search and filter utility can be built. c. Assignments for form data processing and validation and use of HTML5 form elements. A web page with form and validated data could be put in a table. The code could be written using table DOM methods and/or HTML DOM methods and/or XML DOM methods. d. Assignments using various events (mouse, keyboard, etc. events for the form elements, drag-and-drop, window, browser, etc.). e. A web component built using HTML, CSS & JavaScript based on a existing Bootstrap component (e.g. Accordion) f. Assignment with the use of a JavaScript library (JQuery, AngularJS, ReactJS, etc.) 3. Server-side programming Assignments a. Assignments to work with HTTP headers for passing data and meta-data, cookies, localStorage b. Assignments to handle data from web forms; handling the request and response payload c. Assignment to manage web sessions d. Assignment to develop a CRUD functionality by connecting to a database; AJAX calls 4. Data-driven web pages Assignments a. Build a dashboard for tourism data or bank branch b. Build a log visualiser c. Build a interactive region-map with drill-down, drill-up d. Take an API for weather forecast api and map it onto GoogleMap/OSM map 5. Mini Project: Developing a Game with HTML, CSS & JavaScript. The game should have at least 500 lines of (HTML+Javascript) code and make use of various mouse/keyboard events	
Pedagogy	Hands-on assignments / tutorials / peer-learning / project	
References/ Readings	1. Robert W. Sebesta, "Programming the World Wide Web", Pearson Education, 8th Edition 2. https://www.w3schools.com/ 3. Steven Holzner, "HTML 5 Black Book", 1st Edition 4. https://www.tutorialspoint.com/ 5. Frank W. Zammetti, "Modern Full-Stack Development", Apress, 1st Edition (2020) 6. https://www.youtube.com/watch?v=xkBheRZTkaw "Data Visualization with D3 – Full Course for Beginners [2022]" (free course from freecodecamp.org)	
Course Outcomes	1. Learner will be able to make decision on what web technology to use and for what purpose 2. Learner will have fair idea on the popular technologies used in website development 3. Learner will appreciate the architecture of web	

	applications and the design decisions 4. Learner will be able to design web applications for data driven	

(Back to Index) (Back to Agenda)

Programme: MSc Integrated
Course Code: IMC-611 **Title of the Course:** Cloud Computing
Number of Credits: 4(4L-0T-0P) **Contact hours:** 48 hours(48L-0T-0P)
Effective from AY: 2022-23

Prerequisites for the course	Web Development, Programming	
Objectives	1. To provide students with the fundamentals and essentials of Cloud Computing. 2. To provide students a sound foundation of Cloud Computing so that they are able to start using and adopting Cloud Computing services and tools in their real life scenarios. 3. To enable students to explore some important cloud computing driven commercial systems such as Google Apps, Microsoft Azure and Amazon Web Services and other businesses cloud applications. 4. To impart knowledge in applications of cloud computing	
Content	**Introduction to Cloud Computing** Cloud Computing Overview: Characteristics – challenges, benefits, limitations, Evolution of Cloud Computing, Cloud computing architecture, Cloud Reference Model (NIST Architecture) **Infrastructure as a Service** Service Model, Characteristics, Benefits, Enabling Technologies Case Study: AWS, OpenStack **Platform as a Service** Service Model, Characteristics, Benefits, Enabling Technologies Case Studies: IBM Bluemix, GAE, Microsoft Azure **Software as a Service** Service Model, Characteristics, Benefits, Enabling Technologies Case Study: Salesforce.com, CRM, Online Collaboration Services **Data Analytics as a Service** Hadoop as a service, MapReduce on Cloud, Chubby locking Service **Introduction to Public and Private Clouds** Shared Resources – Resource Pool – Usage and Administration Portal – Usage Monitor – Resource Management– Cloud Security – Workload Distribution – Dynamic provisioning. **Storage as a service** Historical Perspective, Datacenter Components, Design Considerations,	6 hours 7 hours 7 hours 7 hours 7 hours 7 hours 7 hours

	Power Calculations, Evolution of Data Centers, Cloud data storage – CloudTM	
Pedagogy	Lectures/ Tutorials/Hands-on assignments/Self-study	
References/ Readings	1) Kai Hwang, Geoffrey Fox, Jack J. Dongarra, Morgan Kaufmann, "Distributed and Cloud Computing: From Parallel Processing to the Internet of Things," 1st Edition, 2011. 2) Gautham Shroff, "Enterprise Cloud Computing: Technology, Architecture, Applications", Cambridge press, 2010. 3) Kris Jamsa, "Cloud Computing", Jones &Barlett Learning, 2013. 4) RajkumarBuyya, James Broberg, AndrzejGoscinski, "Cloud Computing Principles and Paradigms", John Wiley & Sons, 2011. 5) John Rhoton and RistoHaukiojal, "Cloud Computing Architectured : Solution Design Handbook", Recursive Press, 2013. 6) George Recse, "Cloud Application Architectures: Building Application and Infrastructure in the Cloud" , O' Reilly Media, First Edition, 2009. 7) DinkarSitaram, GeethaManjunathan, "Moving to the Cloud: Developing Apps in the new world of Cloud Computing", Syngress, 2012. 8) Samee. U. Khan, Albert. Y. Zomaya, "Handbook on Data Centers", Springer, 2015.	
Course Outcomes	1. Design, Develop & Demonstrate real-world applications from the Cloud Computing 2. The subtle architectural difference in Public and Private Clouds. 3. The requirements of various service paradigms in Cloud Computing. 4. The methods of processing multimedia elements and other information presentation concepts during multimedia communications.	

(Back to Index) (Back to Agenda)

Programme: MSc Integrated
Course Code: IMC-710 **Title of the Course:** Advanced Database Management Systems
Number of Credits: 4(2L-0T-2P) **Contact hours:** 72 hours (24 L-0T-48P)
Effective from AY: 2022-23

Prerequisites for the course	Database Management Systems	
Objectives	• To evaluate emerging architectures for database management systems. • To develop an understanding of the manner in which relational systems are implemented and the implications of the techniques of implementation for database performance. • To assess the impact of emerging database standards on the facilities which future database management systems will provide.	
Content	**Unit 1** Theoretical concepts, Relational model conformity and Integrity,	6 hours

	Advanced SQL programming **Unit 2** Query optimization, Concurrency control and Transaction management, Database performance tuning, Distributed relational systems and Data Replication **Unit 3** Object oriented, deductive, spatial, temporal and constraint database management systems, New database applications and architectures: e.g. Data Warehousing; Multimedia; Mobility; NoSQL, Native XML databases (NXD), Document oriented databases **Unit 4** SQL standards development, Standards for interoperability and integration e.g. Web Services Unit 5 Database security - Data Encryption, redaction and masking techniques. Authentication and authorization. Database auditing	6 hours 6 hours 6 hours
List of Experiments (Indicative)		
1.	Basic SQL Intermediate SQL Advanced SQL	6 hours
2.	ER Modeling	6 hours
3.	Database Design and Normalization	6 hours
4.	Accessing Databases from Programs using JDBC	6 hours
5.	Building Web Applications using PHP & MySQL	6 hours
6.	Indexing and Query Processing	6 hours
7.	Query Evaluation Plans	6 hours
8.	Concurrency and Transactions	6 hours
Pedagogy	Lectures/ tutorials/assignments/self-study	
References/ Readings	**Text Book:** 1. Date C. J., An Introduction to Database Systems, AddisonWesley Longman (8th Ed), 2003. 2. Silberschatz A., Korth H., and Sudarshan S., Database System Concepts, McGraw-Hill (6th Ed), 2010. **Reference Book:** 1. Melton, J., & Simon A., SQL 1999, Understanding Relational Language Components, Morgan Kaufmann, 2003. 2. Peter Adams : SQL: The Ultimate Guide from Beginner to Expert - Learn and Master SQL in No Time, Addison Wesley, 2016.	
Course Outcomes	1. Critically assess new developments in database technology 2. Interpret and explain the impact of emerging database standards 3. Evaluate the contribution of database theory 4. Understand the practical implementations of database management systems.	

(Back to Index) (Back to Agenda)

Programme: MSc Integrated
Course Code: IMC-711 **Title of the Course:** Data Warehousing and Data Mining
Number of Credits: 4(4L-0T-0P) **Contact hours:** 48 hours(48 L-0T-0P)
Effective from AY: 2022-23

Prerequisites for the course	Probability and Statistics	
Objectives	Data warehousing and data mining are the essential components of decision support systems for the modern day industry and business. These techniques enable the knowledge worker (analyst, manager, executive) to make better and faster decisions. The objective of this course is to introduce the student to various Data Warehousing and Data Mining concepts and techniques. A database perspective has to be used throughout the course to introduce principles, algorithms, architecture, design and implementation of data mining and data warehousing techniques.	
Content	**Introduction and Background:** Introduction to the multidisciplinary field of data mining. Discussion on the evolution of database technology that has led to the need for data warehousing and data mining. Stress on importance of its application potential. Introduction to the different key words and techniques. **Data Warehousing And OLAP:** Insight of data warehouse and on-line analytical processing, AggregationOperations, models for data Warehousing, star schema, fact and dimension tables Conceptualization of data warehouse and multidimensional databases. Life cycle of data warehouse development. Relationship between data warehouse and data mining. **Data Mining Primitives:** Data preprocessing including data cleaning, data integration, data transformation. Definition and Specification of a generic data mining task. Description of Data mining query language with few example queries. **Association Analysis:** Different methods(algorithms) for mining association rules in transaction based databases. Illustration of confidence and support. Multidimensional and multilevel association rules. Classification of association rules. Discussion on few association rule algorithms e.g. Apriori, frequent pattern growth etc. **Classification and Predictions:** Different Classification algorithm, including C4.5, CART etc., use of genie index, decision tree induction, Bayesian classification, neural network technique of back propagation, fuzzy set theory and genetic algorithms. **Clustering:** Partition based clustering, Hierarchical clustering, model based clustering for continuous and discrete data. Discussion on scalability of clustering algorithms. Parallel approaches for clustering. **Web Mining:** Web usage mining, web content mining, web log attributes. Use of web mining in efficient surfing and personalization **Mining Complex Type of Data:** Data mining issues in object oriented	6 hours 6 hours 12 hours 12 hours 12 hours

	databases, spatial databases and multimedia databases, time series databases, and text databases. **Applications of Data Warehousing And Data Mining:** Exploration of websites on data warehousing and data mining applications including bibliography databases, Corporate Houses and Research labs.	
Pedagogy	Lectures/ Tutorials/Hands-on assignments/Self-study	
References/ Readings	**Main Reading:** 1. Jiawei Han and MichelineKamber, "Data Mining Concepts and Techniques," 1st Edition Indian Reprint 2001, Harcourt India Private Limited, ISBN 1-55860-489-8. 2. Margaret Dunham, "Data Mining: Introductory and Advanced Topics," 1st Edition, 2003, Prentice Hall (Pearson Publication), ISBN 0-13-088892-3. 3. Arun K Pujari, "Data Mining Techniques". University Press, 2001. **Supplementary Reading** 1. T. Mitchell, "Machine Learning", 1997, McGraw Hill. 2. S.M. Weiss and N. Indurkhya, "Predictive Data Mining", 1998, Morgan Kaufmann. 3. M. Jarke, M. Lenzerni, Y. Vassiliou, and P. Vassiladis, "Fundamentals of Data Warehouses", 2000, Springer Verlag, Isbn 3-540-65365-1.	
Course Outcomes	1. Understand Data Warehousing And OLAP 2. Understand Data Mining Primitives, Association Analysis 3. Understand Classification and Predictions, Clustering 4. Web Mining, Mining Complex Type of Data and applications of data mining and data warehousing.	

Programme: MSc Integrated
Course Code: IMC-712 **Title of the Course:** Domain Specific Predictive Analytics
Number of Credits: 4(4L-0T-0P) **Contact hours:** 48 hours(48L-0T-0P)
Effective from AY: 2022-23

Prerequisites for the course	Data science fundamentals and programming background	
Objectives	It introduces theoretical foundations, algorithms, methodologies for analyzing data in various domains such Retail, Finance, Risk and Healthcare.	
Content	**Retail Analytics** Understanding Customer: Profiling and Segmentation, Modelling Churn. Modelling Lifetime Value, Modelling Risk, Market Basket Analysis. **Risk Analytics** Risk Management and Operational Hedging: An Overview, Supply Chain Risk Management, A Bayesian Framework for Supply Chain Risk Management, Credit Scoring and Bankruptcy Prediction	8 hours 8 hours 8 hours

	Financial Data Analytics Financial News analytics: Framework, techniques, and metrics, News events impact market sentiment, Relating news analytics to stock returns **Financial Time Series Analytics** Financial Time Series and Their Characteristics, Common Financial Time Series models, Autoregressive models, Markov chain models, Time series models with leading indicators, Long term forecasting **Introduction HealthcareAnalytics** An Introduction to Healthcare Data Analytics, Electronic Health Records, Privacy-Preserving Data Publishing Methods in Healthcare, Clinical Decision Support Systems **Healthcare Data Analytics** Natural Language Processing and Data Mining for Clinical Text: Core NLP Components, Information Extraction and Named Entity Recognition, Social Media Analytics for Healthcare: Tracking of Infectious Disease Outbreaks, Readmission risk prediction. **Genomic Data Analytics** Microarray Data, Microarray Data Analysis , Genomic Data Analysis for Personalized Medicine , Patient Survival Prediction from Gene Expression Data , Genome Sequence Analysis	8 hours 8 hours 8 hours
Pedagogy	Lectures/ tutorials/assignments/self-study	
References/ Readings	1. Chris Chapman, Elea McDonnell Feit "R for Marketing Research and Analytics", Springer, 2015. 2. Olivia Parr Rud “Data Mining Cookbook: Modeling Data for Marketing, Risk, and Customer Relationship Management”, Wiley, 2001. 3. Chandan K. Reddy, Charu C. Aggarwal "Healthcare Data Analytics", CRC Press, 2015. 4. Rene Carmona "Statistical Analysis of Financial Data in R", Springer, 2014. 4. James B. Ayers “Handbook Of Supply Chain Management” Auerbach Publications, 2006. 5. PanosKouvelis, Lingxiu Dong, OnurBoyabatli, Rong Li "The Handbook of Integrated Risk Management in Global Supply Chains", Wiley, 2012.	
Course Outcomes	1. Understand Retail Analytics 2. Understand Risk Analytics 3. Understand Financial Data Analytics, Financial Time Series Analytics 4. Understand Healthcare Analytics, Healthcare Data Analytics	

	and Genomic Data Analytics.	

(Back to Index) (Back to Agenda)

Programme: MSc Integrated
Course Code: IMC-713 **Title of the Course:** Image processing
Number of Credits: 6(4L-0T-2P) **Contact hours:** 96 hours(48L-0T-48P)
Effective from AY: 2022-23

Prerequisites for the course	Programming Skills(Java/Python)	
Objectives	• To introduce the concepts of image processing and basic analytical methods to be used in image processing. • To familiarize students with image enhancement and restoration techniques. • To explain different image compression techniques. • To introduce segmentation and morphological processing techniques.	
Content	**Introduction:** Image formation model, representation, spatial and Gray Level resolution, Colour models-RGB, CMY and HIS models **Image Enhancement In Spatial Domain:** Piecewise linear transformation, Histogram equalization,Histogram specification, image averaging, spatial filters – smoothing and sharpening, Laplacian filter, sobel operator, Canny edge detector. **Image Enhancement In Frequency Domain:** 2D Discrete Fourier transform and its inverse, filtering in frequency domain, Ideal and Gaussian Low pass filters, high pass filtering, separability property 0f 2D Fourier transform, Fast Fourier Transform. **Image Segmentation:** Line detection, Edge detection, Edge linking and boundary detection, Hough Transform, Thresholding, Region based segmentation **Morphological Image Processing:** Logic operations involving binary images, Dilation and Erosion, Opening and closing, Applications to Boundary extraction, region filling, connected component extraction. **Image Compression:** Coding redundancy- Huffman coding, LZW coding, run length coding, Lossy compression – Lossy predictive coding, transform coding- DCT, bit allocation, Compression standards – JPEG, video Compression. **Image Representation:** Boundary description, Shape numbers, Fourier descriptors, Texture, principal Components based description.	12 hours 12 hours 12 hours 12 hours
	Suggested Lab Assignments – 1. Program to calculate Fourier Transform of an Image 2. Program to calculate the Grayscale Histogram of an Image 3. Program to perform Median Filtering 4. Program to obtain the Gradient Image using Sobel-Operator. 5. Program for Optimal Thresholding Segmentation.	**(8 * 6 = 48 hours)**

	6. Program for Border-Tracing. 7. Program for Binary Erosion. 8. Program to generate the Binary Skeleton of an Image.	
Pedagogy	Lectures/ tutorials/assignments/self-study	
References/ Readings	**Main Reading:** 1. Gonzalez and Woods, "Digital Image Processing"' 2002, Pearson education, Asia. 2. Sonka, Hlavac and Boyle Brooks/Cole, "Image Processing, Analysis, and Machine Vision", 1999, Thomson Asia Pte Ltd Singapore. **Supplementary Reading:** 1. Jain and Rangachar, "Machine Vision", 1999, McGraw Hill International Edition. 2. Schalkoff, John Wiley and Sons, "Digital Image Processing & Computer, 1989.	
Course Outcomes	1. Explain the fundamentals of digital image and its processing 2. Perform image enhancement techniques in spatial and frequency domain. 3. Elucidate the mathematical modelling of image restoration and compression 4. Apply the concept of image segmentation.	

(Back to Index) (Back to Agenda)

Programme: MSc Integrated
Course Code: IMC-714 **Title of the Course:** Industry 4.0
Number of Credits: 4(4L-0T-0P) **Contact hours:** 48 hours (48L-0T-0P)
Effective from AY: 2022-23

Prerequisites for the course	Programme prerequisites and fundamentals of data science , machine learning	
Objectives	To describe various facets of Industry 4.0, to connect questions raised by Industry 4.0 with appropriate data science techniques, to develop data science tools for Industry 4.0, and to build data-centric business models.	
Content	Introduction to Industry 4.0 – Evolution and history Pillars of Industry 4.0 Industry 4.0 – India context Supplier selection as a classification problem Manufacturing 4.0 Prognosis Quality 4.0 Inventory Optimization Dynamic Pricing Logistics 4.0 Future of Manufacturing Business Focus on new paradigm Next decade of Industry 4.	12 hours 12 hours 12 hours 12 hours

Pedagogy	Lectures/ Tutorials/Hands-on assignments/Self-study	
References/ Readings	1. Industry 4.0: Increasing the Competitiveness of Industrial Manufacturing. Published by Intueri, 2011 2. Industry 4.0: The Industrial Internet of Things by Alasdair Gilchrist, 2011 3. The Fourth Industrial Revolution by Klaus Schwab 4. Sustainability in Manufacturing Enterprises: Concepts, Analyses and Assessments for Industry 4.0 by Ibrahim Garbie,2016 5. Industry 4.0: Managing the digital transformation by Alp ustantag, Emrycevikan, 2018.	
Course Outcomes	1. understand Evolution and history of Industry 4.0, Pillars 2. understand India context, Supplier selection as a classification problem 3. understand Manufacturing 4.0, Prognosis, Quality 4.0, Inventory Optimization, Dynamic Pricing, Logistics 4.0 4. Future of Manufacturing Business Focus on new paradigm and Next decade of Industry 4.0.	

Programme: MSc Integrated
Course Code: IMC-715 **Title of the Course:** Information Retrieval
Number of Credits: 4(4L-0T-0P) **Contact hours:** 48 hours (48L-0T-0P)
Effective from AY: 2022-23

Prerequisites for the course	Linear Algebra, Programming skills	
Objectives	Basic and advanced techniques for text-based information systems: efficient text indexing; Boolean and vector based retrieval models; Web search including crawling.	
Content	**Overview of Information Retrieval:** Function of an IR system, Kinds of IR systems, Components of an IR system, Problems in designing an IR system.The nature of unstructured and semi-structured text. **Text Analysis and Indexing:** Preliminary stages of text analysis and document processing, tokenization, stemming, lemmatization, stop words, phrases, Indexing: Boolean IR models, inverted files, indexing, signature files, PAT trees, Positional indices. Vector-based IR models: TF/IDF term weighing, similarity measures, test collections and issues. **Index construction and Compression:** Postings size estimation, merge sort, dynamic indexing, positional indexes, n-gram indexes. Index compression: lexicon compression and postings lists compression. Gap encoding, gamma codes, Zipf's Law. Blocking. Extreme compression. **Query Processing:** Query expansion: spelling correction and synonyms. Wild-card queries, permuterm indices, n-gram indices. Edit distance, soundex,	12 hours 12 hours 12 hours

	language detection. **Matching techniques:** Similarity between documents and queries, Parametric or fielded search. Document zones. The vector space retrieval model, tf.idf weighting. Scoring documents, vector space scoring, the cosine measure, efficiency considerations, reduced dimensionality approximations, Latent Semantic Indexing (LSI), random projection, Page Ranking and HITS. **Information Extraction:** Information extraction, Named entity extraction, Question Answering. Summarization - Qualities of good summary, summary types, extract summary. **Evaluation of IR systems:** Assessment of the performance of IR systems - Precision, Recall, F-Measure. Criteria for evaluation, measuring 'goodness', tests of IR systems. Presentation of search results, display of search results, manipulation of search results. **Relevance feedback:** User modeling and information need: user profiling, Relevance judgments. Additional term selections to the system, Dynamic respond ally to judgments and selections, Personalization of search. **Taxonomy and Ontology:** Creating domain specific ontology, Ontology life cycle. **Distributed and Parallel IR:** Relationships between documents, Identify appropriate networked collections, Multiple distributed collections simultaneously. **Web Search Engines:** Web crawlers, robot exclusion, Web data mining, Metacrawler, Collaborative filtering, Web agents (web shopping, bargain finder, …), Economic, ethical, legal and political issues. **Multimedia IR:** Techniques to represent audio and visual documents, Query databases of multimedia documents, Display the results of multimedia searches.	12 hours
Pedagogy	Lectures/ tutorials/assignments/self-study	
References/ Readings	1. Managing Gigabytes, by I. Witten, A. Moffat, and T. Bell, 1999. 2. Modern Information Retrieval, by R. Baeza-Yates and B. Ribeiro-Neto, 1999. 3. Information Retrieval: Algorithms and Heuristics by D. Grossman and O. Frieder, 1998.	
Course Outcomes	1. Understand Overview of Information Retrieval 2. Text Analysis and Indexing, Index construction and Compression 3. Query Processing, Matching techniques, Information Extraction, Evaluation of IR systems, Relevance feedback, Taxonomy and Ontology	

	4. Distributed and Parallel IR, Web Search Engines and Multimedia IR.	

(Back to Index) (Back to Agenda)

Programme: MSc Integrated
Course Code: IMC-716 **Title of the Course:** IoT
Number of Credits: 4(4L-0T-0P) **Contact hours:** 48 hours (48L-0T-0P)
Effective from AY: 2022-23

Prerequisites for the course	Internet Technologies, Computer Organization and architecture, Operating Systems.	
Objectives	To understand the fundamentals of Internet of Things and the protocols and standards designed for IoT	
Content	Introduction to IoT: Introduction, IoT ecosystem, Applications, Challenges. Fundamentals: IoT Devices - Sensors, Actuators, and gateways, Basics of the wireless sensor network. IoT Architecture & Design: oneM2M, IoTWF, Additional Reference Models, Core functional stack, Data Management and compute stack. Communicating smart objects: Communication criteria, communication models, IoT access technologies – 3GPP MTC, IEEE 802.11, IEEE 802.15, Wireless HART, ZWave, Bluetooth Low Energy, Zigbee Smart Energy, DASH7 IoT Network Layer: IP as IoT network layer, IPv6, 6LoWPAN, 6TiSCH, RPL, CORPL, CARP IoT Transport and Application protocols: Transport Layer: TCP, UDP, DCCP, SCTP, TLS, DTLS IoT application transport methods, HTTP, CoAP, XMPP, MQTT, AMQP, DDS IoT Transport and Application protocols: Transport Layer: TCP, UDP, DCCP, SCTP, TLS, DTLS IoT application transport methods, HTTP, CoAP, XMPP, MQTT, AMQP, DDS Security in IoT: MAC802.15.4, 6LoWPAN, RPL, Application Layer security. IoT Application case study: Discuss any 3 applications of IoT	10 hours 14 hours 14 hours 10 hours
Pedagogy	Lectures/ Tutorials/Hands-on assignments/Self-study	
References/ Readings	1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, “IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things”, CISCO Press, 2017 2. Hersent, Olivier, David Boswarthick, and Omar Elloumi, The internet	

	of things: Key applications and protocols. John Wiley & Sons, 2011. 3. Buyya, Rajkumar, and Amir VahidDastjerdi, eds. Internet of Things: Principles and Paradigms. Elsevier, 2016.	
Course Outcomes	1. Understand IoT protocols. 2. Implement IoT communication using protocols. 3. Secure IoT communication. 4. Enable interoperability among IoT devices.	

Programme: MSc Integrated
Course Code: IMC-717 **Title of the Course:** Numerical Methods
Number of Credits: 4(4L-0T-0P) **Contact hours:** 48 hours(48L-0T-0P)
Effective from AY: 2022-23

Prerequisites for the course	Basic knowledge of multivariate calculus and elementary real analysis	
Objectives	Aimed at imparting numerical techniques required for dealing with data of scientific applications and builds Foundations for solving equations for Machine Learning models	
Content	**Root finding:** Functions and polynomials, zeros of a function, roots of a nonlinear equation, bracketing, bisection, secant, and Newton-Raphson methods. Interpolation, splines, polynomial fits, Chebyshev approximation. **Numerical Integration and Differentiation:** Evaluation of integrals, elementary analytical methods, trapezoidal and Simpson's rules, Romberg integration, Gaussian quadrature and orthogonal polynomials, multidimensional integrals, summation of series, Euler-Maclaurin summation formula, numerical differentiation and estimation of errors. **Optimization:** Extremization of functions, simple search, Nelder-Mead simplex method, Powell's method, gradient-based methods, simulated annealing. **Complex analysis:** Complex numbers, functions of a complex variable, analytic functions, conformal mapping, Cauchy's theorem. Calculus of residues. Fourier and Laplace Transforms, Discrete Fourier Transform, z transform, Fast Fourier Transform (FFT), multidimensional FFT, basics of numerical optimization.	10 hours 14 hours 10 hours 14 hours
Pedagogy	Lectures/ Tutorials/Hands-on assignments/Self-study	
References/ Readings	• Richard L. Burden and J. Douglas Faires, Numerical Analysis: Theory and Applications, India Edition, Cengage Brooks-Cole Publishers, 2010. • Press, W.H., Teukolsky, S.A., Vetterling, W.T., and Flannery, B.P., Numerical Recipes in C/FORTRAN, Prentice Hall of India, New Delhi,	

	1994. • Borse, G.J., Numerical Methods with MATLAB: A Resource for Scientists and Engineers, PWS Publishing Co., Boston, 1997.	
Course Outcomes	1. Understand and apply numerical algorithms. 2. Implement numerical methods for problem-solving. 3. Analyze and quantify numerical errors. 4. Apply numerical methods to real-world problems.	

Programme: MSc Integrated
Course Code: IMC - 910 **Title of Course:** Programming Paradigms
Number of Credits: 4 (4L-0T-0P) **Contact hours:** 48 hours (48L-0T-0P)
Effective from AY: 2022-23

Prerequisites for the course	Knowledge of programming	
Objectives	To learn and understand various programming paradigms.	
Content	**Understanding Programming Paradigm** • Programming paradigm concept, motivation, types and classification of paradigms. • Factors with respect to programming languages: Binding times and flexibility; Scoping; First class values; Abstraction; Typing; Storage Allocation & Dynamic Memory	6 hours
	Imperative Programming • Variables and data types; Operators and expressions; Input/Output operations, Decision constructs; Looping constructs • Procedural (*in Python/C*) -- blocks & scope; procedures (functions) • Object Oriented (*in Java/C++*) -- classes & objects, object-oriented principles (encapsulation, abstraction, inheritance, polymorphism)	6 hours
	Functional Programming (*in Haskell/Clojure/Scala*) • Revision of mathematical Functions' concepts • Side effects; Pure functions • Type induction • Defining functions • Currying; Function composition • Recursion • Lazy evaluation; infinite lists • List comprehensions • Higher order functions; Folds	10 hours
	Logic Programming (*in Prolog/ECLiPSe Constraint language*) • Revision of mathematical Logic concepts • Programming "without algorithms" • Logic programming with facts, rules and goals	10 hours

	• Recursion; Lists • Constraint logic programming; constraints as relationship between variables; solving puzzles (like sudoku)	
	Event-driven Programming (*in Python/.NET*) • Events • Main loop & callback • Scheduler & Event handlers; Triggers • Exception handling • Reliable eventing • Asynchronous triggers	8 hours
	Multi-Paradigms and more • Language support for multi paradigms; Benefits & issues • Parallel programming -- Data Parallelism (*in OpenMP*) and Message Passing (*in MPI*) • Reactive programming (*in Elm/ReactiveX for Java, JS*) • Meta programming (*in Lisp*) • Natural Language Programming (*in SciLab/MATLAB*)	8 hours
Pedagogy	Hands-on assignments / tutorials / peer-teaching / pair programming/ reading research papers/ presentations	
References/ Readings	• Terrance W. Pratt, Marvin V. Zelkowitz, "Programming Languages - Design & Implementation" • Robert L. Sebesta, "Concepts of Programming Languages" • Ravi Sethi, "Programming Languages Concepts & Constructs" • Bruce J. Mac Lennan, "Principles of Programming Languages: Design, Evaluation, and Implementation" • Kenneth C. Louden, "Programming Languages: Principles and Practice" • Allen Tucker, Robert Noonan, "Programming Languages: Principles and Paradigms" • Graham Hutton, "Programming in Haskell" • W. Clocksin, "Programming in Prolog" • Slim Abdennadher, Thom Frühwirth, "Essentials of Constraint Programming" • Roland Kuhn, Brian Hanafee, Jamie Allen, "Reactive Design Patterns"	
Course Outcomes	1. Learner will be able to distinguish between different programming paradigms 2. Learner will be able to choose an adequate programming paradigm in solving specific software engineering problems 3. Learner will be able to recognize the similar concepts 4. How they are implemented in a different way across different programming languages and paradigms	

Programme: MSc Integrated
Course Code: IMC-911 **Title of the Course:** Sequential Decision Making

Number of Credits:4(4L-0T-0P) **Contact hours:** 48 hours(48L-0T-0P)
Effective from AY: 2022-23

Prerequisites for the course	Machine learning	
Objectives	Introductory level course for sequential decision making. It helps learners to find a stopping rule that optimizes the decision in terms of minimizing losses or maximizing gains , including observation costs.	
Content	Introduction to Online Learning, Halving algorithm Online Machine Learning; Perceptron and Winnow Intro to Regret; Online learning with expert advice - Hedge algorithm Online linear optimization Online convex optimization; Online learning summary Introduction to Multi armed Bandits - EXP3 Contextual MAB - EXP4 Stochastic MAB, Epsilon Greedy, Explore then commit Stochastic MAB, UCB, Thompson Sampling Stochastic MAB - Linear Bandits - LinUCB algorithm; MAB summary Introduction to Reinforcement Learning - Markov Decision Process Q-learning	12 hours 12 hours 12 hours 12 hours
Pedagogy	Lectures/ Tutorials/Hands-on assignments/Self-study	
References/ Readings	1. Sequential decision making problems by cedricpralet,Thomasschiex,Gerard. 2. Introduction to sequential decision making by yanchen, chiicyuwang,Rayliu.	
Course Outcomes	1. Understand the differences between the various sequential decision making problems based on the type of feedback involved 2. Recognize practical ML problems as sequential decision making problems whenever they are 3. Learn about optimal algorithms for several sequential decision making settings 4. Apply the algorithms studied in the course to various practical sequential decision making scenarios.	

Programme: MSc Integrated
Course Code: IMC-912 **Title of the Course:** Soft Computing
Number of Credits: 6(4L-0T-2P) **Contact hours:** 96 hours (48L-0T-48 P)
Effective from AY: 2022-23

Prerequisites for the course	Machine Learning	
Objectives	The objective of this course is to introduce methods for handling imprecise and uncertain data using Rough sets, Neuro Fuzzy Systems	

	and foster their abilities in designing and implementing optimal solutions for real-world and engineering problems using derivative free optimization techniques.	
Content	**Module: 1 Introduction to Soft Computing** Soft Computing Overview – Uncertainty in data, Hard vs Soft Computing **Module: 2 Neural Networks** Introduction, RBF Networks, Self-Organizing Map, Boltzmann Machines, Convolutional Neural Networks. **Module: 3 Fuzzy Systems** Fuzzy Sets, Fuzzy Relations, and Membership functions, Properties of Membership functions, Fuzzification and Defuzzification. **Module: 4 Fuzzy logic** Fuzzy Rule based systems, Fuzzy Decision making, Fuzzy Classification, Fuzzy CMeans Clustering. **Module: 5 Rough Sets** Rough Sets – Definition, Upper and Lower Approximations, Boundary Region, Decision Tables and Decision Algorithms. Properties of Rough Sets. Rough K-means clustering, Rough **Module: 6 Optimization Techniques** Introduction, Genetic Algorithm, Memetic Algorithms, Particle Swarm Optimization, Ant Colony Optimization, Frog-Leaping. **Module: 7 Hybrid Systems** GA Based Back Propagation Networks, Fuzzy Back Propagation Networks, Evolutionary Ensembles	8 hours 10 hours 10 hours 10 hours 10 hours
	Any 6 to be implemented in any programming language. • Develop Fuzzy Decision-Making for Job Assignment Problem • Implement TSP using Optimization Techniques • Develop a suitable method for Health Care Application using Neuro- Fuzzy Systems • Develop a suitable method for Face Recognition System • Layout Optimization using Genetic Algorithms • Fault Diagnosis using rough set theory • Software safety analysis using rough sets A Neuro-fuzzy Approach to Bad Debt Recovery in Healthcare	6 * 8 = 48 hour
Pedagogy	Assignment / Quiz / Project / Seminar	
References/ Readings	Main Readings 1. S.N. Sivanandham and S.N.Deepa, “Principles of Soft Computing”, 2nd Edition, Wiley Publications. 2. Andries P. Engelbrecht, "Computational Intelligence: An Introduction", John Wiley & Sons,2007. 3. Laurene V. Fausett “Fundamentals of Neural Networks: Architectures, Algorithms And Applications”, Pearson,1993. 4. Simon Haykin "Neural Networks and Learning Machines" Prentice Hall,2008. Timothy Ross, “Fuzzy Logic with Engineering Applications”, Third Edition,Wiley.	

Course Outcomes	1. Have a general understanding of soft computing methodologies, to deal with imprecise and uncertain data 2. Develop computational neural network models for some simple biological systems; 3. Develop fuzzy models for engineering systems, particularly for control systems; 4. Apply derivative free optimization methods to solve real world problems Demonstrate some applications of computational intelligence Student Learning Outcomes (SLO):	

(Back to Index) (Back to Agenda)

Programme: MSc Integrated
Course Code: **IMC-913** **Title of the Course:** Stream Processing and Analytics
Number of Credits: 6(4L-0T-2P) **Contact hours:** 96 hours (48 L-0T-48 P)
Effective from AY: 2022-23

Prerequisites for the course	None	
Objectives	It introduces theoretical foundations, algorithms, methodologies, and Applications of streaming data and also provides practical knowledge for handling and analyzing streaming data.	
Content	**Module:1 Introduction** Characteristics of the data streams, Challenges in mining data streams Requirements and principles for real time processing, Concept drift Incremental learning. **Module:2 Data Streams** Basic Streaming Methods, Counting the Number of Occurrence of the Elements in a Stream, Counting the Number of Distinct Values in a Stream, Bounds of Random Variables, Poisson Processes, Maintaining Simple Statistics from Data Streams, Sliding Windows, Data Synopsis, Change Detection: Tracking Drifting Concepts, Monitoring the Learning Process **Module:3 Decision Trees** The Very Fast Decision Tree Algorithm (VFDT), The Base Algorithm, Analysis of the VFDT Algorithm, Extensions to the Basic Algorithm: Processing Continuous Attributes, Functional Tree Leaves, Concept Drift. **Module:4 Clustering from Data Streams** Clustering Examples: Basic Concepts, Partitioning Clustering - The Leader Algorithm, Single Pass k-Means, Micro Clustering, Clustering Variables: A Hierarchical Approach **Module:5 Frequent Pattern Mining** Mining Frequent Itemsets from Data Streams- Landmark Windows, Mining Recent Frequent Itemsets, Frequent Itemsets at Multiple Time Granularities Sequence Pattern Mining- Reservoir Sampling for Sequential Pattern Mining over data streams **Module:6 Evaluating Streaming Algorithms**	8 hours 8 hours 8 hours 8 hours 8 hours 8 hours

	Evaluation Issues, Design of Evaluation Experiments, Evaluation Metrics, Error Estimators using a Single Algorithm and a Single Dataset, Comparative Assessment, The 0-1 loss function, Evaluation Methodology in Non-Stationary Environments, The Page-Hinkley Algorithm. **Module:7 Complex Event Processing** Introduction to Complex Event Processing, Features of CEP, Need for CEP, CEP Architectural Layers, Scaling CEP, Events, Timing and Causality, Event Patterns, Rules and Constraint, STRAW-EPL, Complex Events and Event Hierarchies	
Pedagogy	Assignment / Quiz / Project / Seminar	
References/ Readings	1. Joao Gama, "Knowledge Discovery from Data Streams", CRC Press, 2010. 2. David Luckham, "The Power of Events: An Introduction to Complex Event Processing in Distributed Enterprise Systems", Addison Wesley, 2002. 3. Charu C. Aggarwal, "Data Streams: Models And Algorithms", Kluwer Academic Publishers, 2007.	
Course Outcomes	1. Recognize the characteristics of data streams that make it useful to solve real-world problems. 2. Identify and apply appropriate algorithms for analyzing the data streams for a variety of problems. 3. Implement different algorithms for analyzing the data streams 4. Identify the metrics and procedures to evaluate a model	

Programme: MSc Integrated
Course Code: IMC-914 **Title of the Course:** Text Analytics and Text Mining
Number of Credits: 6(4L-0T-2P) **Contact hours:** 96 hours(48 L-0T-48P)
Effective from AY: 2022-23

Prerequisites for the course	Machine Learning, Probability and Statistics.	
Objectives	Widely used in knowledge-driven organizations, text mining is the process of examining large collections of documents to discover new information or help answer specific research questions. Text mining identifies facts, relationships and assertions that would otherwise remain buried in the mass of textual big data.	
Content	An overview of natural language processing techniques and text representation, which are the foundation for all kinds of text-mining applications, and word association mining with a particular focus on mining one of the two basic forms of word associations (i.e., paradigmatic relations) Word association mining with a particular focus on mining the other	6 hours 6 hours

	basic form of word association (i.e., syntagmatic relations), and start learning topic analysis with a focus on techniques for mining one topic from text. Topic analysis in depth, including mixture models and how they work, Expectation-Maximization (EM) algorithm and how it can be used to estimate parameters of a mixture model, the basic topic model, Probabilistic Latent Semantic Analysis (PLSA), and how Latent Dirichlet Allocation (LDA) extends PLSA. Text clustering, including the basic concepts, main clustering techniques, including probabilistic approaches and similarity-based approaches, and how to evaluate text clustering. You will also start learning text categorization, which is related to text clustering, but with predefined categories that can be viewed as pre-defining clusters. Various methods for text categorization, including multiple methods classified under discriminative classifiers, and you will also learn sentiment analysis and opinion mining, including a detailed introduction to a particular technique for sentiment classification (i.e., ordinal regression). Sentiment analysis and opinion mining with a focus on Latent Aspect Rating Analysis (LARA), and you will learn about techniques for joint mining of text and non-text data, including contextual text mining techniques for analyzing topics in text in association with various context information such as time, location, authors, and sources of data	12 hours 12 hours 12 hours
	Suggested Lab Assignments 1. Programming exercises to understand the basic library of python-NLTK, Numpy and Scipy Write program to implement naïve bayes classifier. 2. Write program to implement hierarchical clustering 3. Write a program to implement a back propagation model of a neural network. 4. Write program to implement forward algorithm of HM 5. Write a program to implement the Viterbi algorithm of HMM. 6. Write program to implement baum Welsh 7. Document level sentiment analysisand Sentence level sentiment analysis 8. Aspect based sentiment analysis	**(8 * 6 = 48 hours)**
Pedagogy	Lectures/ Tutorials/Hands-on assignments/Self-study	

References/ Readings	1. Natural Language Processing with Python by Steven Bird, Ewan Klein and Edward Loper. 2. Text Mining with R by Julia Silge and David Robinson. 3. Taming Text by Grant Ingersoll, Thomas Morton and Drew Farris. 4. Deep Learning in Natural Language Processing by Li Deng, Yang Liu.	
Course Outcomes	1. Understand artificial intelligence (AI) technology that uses natural language processing (NLP) 2. Understand how to transform the free (unstructured) text in documents 3. Understand how to transform databases into normalized, structured data suitable for analysis or 4. To drive machine learning (ML) algorithms.	

(Back to Index) (Back to Agenda)

Programme: MSc Integrated
Course Code: IMC-915 **Title of the Course:** Video Analytics
Number of Credits: 4(4L-0T-0P) **Contact hours:** 48 hours(48L-0T-0P)
Effective from AY: 2022-23

Prerequisites for the course	Image Processing, Probability, Linear Algebra.	
Objectives	The main goal of video analytics is to automatically recognize temporal and spatial events in videos. A person who moves suspiciously, traffic signs that are not obeyed, the sudden appearance of flames and smoke; these are just a few examples of what a video analytics solution can detect.	
Content	Revisit to Digital Image and Video Processing Camera Models Background Modelling Object Detection and Recognition Local Feature Extraction Biologically Inspired Vision Object Classification Segmentation Object Tracking Activity Recognition Anomaly Detection Handling Occlusion Scale and Appearance changes Other Applications	12 hours 12 hours 12 hours 12 hours
Pedagogy	Lectures/ Tutorials/Hands-on assignments/Self-study	

References/ Readings	1. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer 2010. 2. Forsyth, D.A., and Ponce, J., Computer Vision: A Modern Approach, Pearson Education, 2003.	
Course Outcomes	1. Understand Digital Image and Video Processing 2. Camera Models, Background Modelling, 3. Object Detection and Recognition, Local Feature Extraction, Biologically Inspired Vision, Object Classification, Segmentation, Object Tracking, Activity Recognition 4. Anomaly Detection, Handling Occlusion, Scale and Appearance changes and Other Applications.	

(Back to Index) **(Back to Agenda)**

Annexure II

M.Sc Integrated (Economics)
Semester VI onwards specific to the Economics Discipline for students opting for M.Sc Integrated (Economics)

Semester I	**Credits**	**Semester II**	**Credits**
Same as M.Sc Integrated (Data Science)	22	Same as M.Sc Integrated (Data Science)	22
Semester III	**Credits**	**Semester IV**	**Credits**
Same as M.Sc Integrated (Data Science)	24	Same as M.Sc Integrated (Data Science)	24
Semester V	**Credits**	**Semester VI**	**Credits**
Same as M.Sc Integrated (Data Science)	26	IMC-641: Experimental Economics	4
		IMC-642: Time Series Econometrics	4
		IMC-643: Auctions Theory	4
		IMC-644: Economic Thought	4
		Elective 1: anyone to be opted from Data Science - IMC- 610 / IMC- 611 / IMC- 710 to IMC- 717	4
		Project Work // internship	6
			26
Semester VII (Discipline:- Economics)	**Credits**	**Semester VIII(Discipline:- Economics)**	**Credits**
IMC-741: Advanced Microeconomics	4	IMC-841: Advanced Macroeconomics	4
IMC-742: Indian Public Finance	4	IMC-842: International Finance	4
IMC-743: Behavioral Economics	4	IMC-843: Theories of Economic Growth	4
IMC-744: Health Economics	4	IMC-844: Information Economics	4
Elective 2: anyone to be opted from Data Science - IMC- 610 / IMC- 611 / IMC- 710 to IMC- 717	4	**Elective 4**: from Data Science - IMC- 802: Optimization Techniques for Analytics	4
Elective 3: from Data Science – IMC- 704: Design thinking for Data	4	**Elective 5**: from Data Science - IMC- 801: Reinforcement Learning	4

	24		24
Semester IX (Discipline:- Economics Science)	**Credits**	**Semester X (Discipline:- Economics Science)**	**Credits**
Elective 6- IMC-941: Research Methodology	4	**IMC-1051: Dissertation OR** **IMC-1052: Internship in Industry**	16
Elective 7- IMC-942: Data Sources for the Indian Economy	4		
Elective 8- IMC-943: Techniques of Geo-Spatial Analysis	4		
Elective 9- IMC-944: Financial Economics	4		
	16		16

(Back to Index) (Back to Agenda)

Name of the Programme: M.Sc Integrated (Economics)
Course Code: IMC-641
Title of the Course: Experimental Economics
Number of Credits: 4(4L-0T-0P)
Effective from AY: 2023-24

Prerequisites for the course:	Standard XII mathematics	
Objectives:	The objective of this course is to familiarise the students with different experimental techniques in Economics	
Content:	**Module I** Introduction to Experimental Economics; Price Discovery and Exclusion; Risk and Decision Making; Prospect Theory and Anomalies **Module II** Bayes' Rule; Belief Elicitation and Ambiguity Aversion; Individual and Social Learning **Module III** Simple Games: Competition, Coordination, and Guessing; Multi-Stage Games, Noisy Behavior; Randomized Strategies; Choice of Partners, Social Dilemmas **Module IV** Contests and Rent Seeking; Methodology, Nonparametric Tests	12 hours 12 hours 12 hours 12 hours
Pedagogy:	● Chalk and talk aided by ICT enabled lectures ● PC lab exercises ● Assignments and presentations ● Group activity	

	● MOOC (or similar) Component	
References/ Readings:	**Core Reading:** 1. Charles A. Holt (2019)Markets, Games, and Strategic Behavior An Introduction to Experimental Economics, Princeton University Press	
Course Outcomes:	On completion of the course successfully, the student will be able to 1. Understand how price affects decision-making under risk. 2. Explain how simple Bayesian methods are used in Economics. 3. Evaluate the use of games in individual and social experiments 4. Explain rent-seeking behaviour using experiments	

(Back to Index) (Back to Agenda)

Name of the Programme: M.Sc Integrated (Economics)
Course Code: IMC-642
Title of the Course: Time Series Econometrics
Number of Credits: 4(4L-0T-0P)
Effective from AY: 2023-24

Prerequisites for the course:	Standard XII mathematics	
Objectives:	This course will introduce students to the use of time series data for econometric analysis	
Content:	**Module I:** **Basic Regression Analysis with Time Series Data:** The Nature of Time Series Data, Static Models, Finite Distributed Lag Models, A Convention about the Time Index, Finite Sample Properties of OLS under Classical Assumptions, Functional Form, Dummy Variables, and Index Numbers, Trends and Seasonality, Characterizing Trending Time Series, Using Trending Variables in Regression Analysis, A Detrending Interpretation of Regressions with a Time Trend. Stationary and Weakly Dependent Time Series, Highly Persistent Time Series, Transformations on Highly Persistent Time Series, Dynamically Complete Models and the Absence of Serial Correlation	12 hours

	Module II: **Serial Correlation and Heteroskedasticity in Time Series Regressions:** Properties of OLS with Serially Correlated Errors, Serial Correlation in the Presence of Lagged Dependent Variables, Testing for Serial Correlation, The Durbin-Watson Test under Classical Assumptions, Testing for AR(1) Serial Correlation without Strictly Exogenous Regressors, Testing for Higher Order Serial Correlation, Correcting for Serial Correlation with Strictly Exogenous Regressors, Feasible GLS Estimation with AR(1) Errors, Comparing OLS and FGLS, Correcting for Higher Order Serial Correlation, Differencing and Serial Correlation, Serial Correlation-Robust Inference after OLS, Heteroskedasticity in Time Series Regressions, Heteroskedasticity-Robust Statistics, Testing for Heteroskedasticity Autoregressive Conditional Heteroskedasticity, Heteroskedasticity and Serial Correlation in Regression	12 hours
	Module III: **Models Pooling Cross Sections across Time:** Simple Panel Data Methods, Pooling Independent Cross Sections across Time, The Chow Test for Structural Change across Time, Policy Analysis with Pooled Cross Sections, Two-Period Panel Data Analysis, Organizing Panel Data, Policy Analysis with Two-Period Panel Data, Differencing with More Than Two Time Periods, Fixed Effects Estimation, The Dummy Variable Regression, Fixed Effects or First Differencing? Fixed Effects with Unbalanced Panels, Random Effects Models, Random Effects or Fixed Effects? The Correlated Random Effects Approach, Applying Panel Data Methods to Other Data Structures	12 hours
	Module IV **Simultaneous Equations Models:** The Nature of Simultaneous Equations Models, Simultaneity Bias in OLS, Identifying and Estimating a Structural Equation, Identification in a Two-Equation System, Estimation by 2SLS, Systems with More Than Two Equations, Identification in Systems with Three or More Equations, Estimation of Simultaneous Equations Models with Time Series, Simultaneous Equations Models with Panel Data, Infinite Distributed Lag Models, The Geometric (or Koyck) Distributed Lag, Rational Distributed Lag Models, Testing for Unit Roots, Spurious Regression, Cointegration and Error Correction Models, Cointegration, Error Correction Models, Forecasting, Types of Regression Models Used for Forecasting, One-Step-Ahead Forecasting, Comparing One-Step-Ahead Forecasts, Multiple-Step-Ahead Forecasts, Forecasting Trending, Seasonal, and Integrated Processes	12 hours
Pedagogy:	● Chalk and talk aided by ICT enabled lectures ● PC lab exercises ● Assignments and presentations ● Group activity	

	● MOOC (or similar) Component	
References/ Readings:	**Core Reading** 1. Wooldridge, J. (2018). Introductory econometrics: A modern approach (7th edition). Cengage Learning. **Additional Reading** 1. Angrist, J. D., & Pischke, J.-S. (2009). Mostly harmless econometrics: An empiricist's companion. Princeton University Press. 2. Heiss, F. (2020). Using R for introductory econometrics.	
Course Outcomes:	On successful completion, students will be able to: 1. Undertake advanced analysis of time series econometric tools 2. Use econometric software with an emphasis on open source for data and graphics 3. Explore differences in analytical approaches of cross-section and time-series data 4. Forecast trends using time series data.	

(Back to Index) (Back to Agenda)

Name of the Programme: M.Sc Integrated (Economics)
Course Code: IMC-643
Title of the Course: Auctions Theory
Number of Credits: 4(4L-0T-0P)
Effective from AY: 2023-24

Prerequisites for the course:	Standard XII mathematics	
Objectives:	The aim of this course is to introduce the students to auctions and how these result in efficient economic outcomes.	
Content:	**Module I** **Single Object Auctions-1** Private Value Auctions; The Revenue Equivalence Principle; Qualifications and Extensions; Mechanism Design; Auctions with Interdependent Values	12 hours
	Module II **Single Object Auctions-2** The Revenue Ranking ("Linkage") Principle; Asymmetries and Other Complications; Efficiency and the English Auction; Mechanism Design with Interdependent Values; Bidding Rings	12 hours
	Module III Equilibrium and Efficiency with Private Values; Some Revenue Considerations; Sequential Sales	12 hours

	Module IV **Multiple Object Auctions-2** Non-identical Objects; Packages and Positions; Multiple Objects and Interdependent Values	12 hours
Pedagogy:	• Chalk and talk aided by ICT enabled lectures • PC lab exercises • Assignments and presentations • Group activity • MOOC (or similar) Component	
References/ Readings:	**Core reading:** 1. Vijay Krishna (2009), Auction Theory, Academic Press. ISBN 9780123745071 **Additional references** 1. Flavio M. Menezes and Paulo K. Monteiro (2008) An Introduction to Auction Theory, OUP Oxford; ISBN: 978-0199275991 2. Pak-Sing Choi and Felix Munoz-Garcia (2021) Auction Theory; Introductory Exercises with Answer Keys, Springer; ISBN: 978-3-030-69574-3 3. Paul Klemperer (2004) Auctions: Theory and Practice, Princeton University Press, ISBN:978069111925	
Course Outcomes:	A student completing this course will be able to 1. Design basic auctions 2. Analyse the efficiency of auction contracts 3. Evaluate auctions and comment on their efficiency 4. Analyse the bidding strategies in auctions	

(Back to Index) (Back to Agenda)

Name of the Programme: M.Sc Integrated (Economics)
Course Code: IMC-644
Title of the Course: Economic Thought
Number of Credits: 4(4L-0T-0P)
Effective from AY: 2023-24

Prerequisites for the course:	Same as programme requirements	
Objectives:	The objective of this course is to give students an overview of the different schools of economic thought and an insight into the evolution of modern economic ideas.	

Content:	**Module 1** **Pre-classical Economic Thought** - Mercantilism: Thomas Mun (1571–1641), Physiocrats: François Quesnay (1694–1774) **The Classical School** - Adam Smith (1723–1790), Thomas, Robert Malthus (1766–1834), David Ricardo (1772–1823), The Marxian Challenge: Karl Marx (1818–1883) **Module 2** **The Marginal Revolution**: William Stanley Jevons, Carl Menger (1840–1921), Léon Walras (1834–1910) **Neoclassical Economics**: Alfred Marshall (1842–1924) **Module 3** **The Modern Macroeconomics Theory**: John Maynard Keynes (1883–1946), Paul A. Samuelson (1915–2009), A.W. Phillips (1914–1975), Milton Friedman (1912–2006) **Module 4** **Indian Economic Thought:** Early Indian Thought, Economic debates during Independence (Gandhian Economics, Ambedkar's ideas, Mahalanobis model), Post-independence ideas (Stagnation debate, Poverty debate, Liberalisation and Privatisation debate)	12 hours 12 hours 12 hours 12 hours
Pedagogy:	● Chalk and talk aided by ICT enabled lectures ● Assignments and presentations ● Group activity ● MOOC (or similar) Component	
References/ Readings:	**Core reading** 1. Medema, S. G., & Samuels, W. J. (Eds.). (2013). The History of Economic Thought: A Reader; Second Edition (2nd ed.). Routledge. https://doi.org/10.4324/9780203568477 2. Ajit Dasgupta, A History of Indian Economic Thought, Routledge history of economic thought series, 1993 [E-book] Available: Taylor & Francis e-Library, 2002 **Additional References** 1. Aiyanger, K.V. Rangaswamy (1934) Aspects of Ancient Indian Thought, Benaras Hindu University, Benaras. https://ignca.gov.in/Asi_data/7536.pdf 2. Ghate, C., Gopalakrishnan, P., & Grover, S. (2022). The Mahalanobis Growth Model: A Macrodynamics Approach. Springer Nature. https://doi.org/10.1007/978-981-16-8980-2 3. Hunt E. K. (2015). History of economic thought: a critical perspective	

	(Third). Routledge. 4. Vaggi, G., & Groenewegen, P. D. (2003). A concise history of economic thought: From mercantilism to monetarism. Palgrave Macmillan.	
Course Outcomes:	On successful completion, students will be able to: 1. Undertake a comparative analysis of different economic thinkers. 2. Understand how these ideas shaped economic policy in their times. 3. Explain how economic transition molded dominant theoretical ideas in different periods. 4. Appreciate the linkages between past and present economic thinking.	

(Back to Index) (Back to Agenda)

Name of the Programme: M.Sc Integrated (Economics)
Course Code: IMC-741
Title of the Course: Advanced Microeconomics
Number of Credits: 4(4L-0T-0P)
Effective from AY: 2023-24

Prerequisites for the Course:	Knowledge of Microeconomics, Macroeconomics and Basic Probability theory.	
Objective:	To familiarise the students with the main elements of the theory of general equilibrium and modern game theory to perform the advanced analytics required in advanced microeconomic theory.	
Content:	**Module 1: General Equilibrium and Economic Welfare** Feedback Between Competitive Markets, Trading Between Two People, Competitive Exchange-Fundamental theorems of Welfare Economics, Pareto Optimality, Production and Trading, Efficiency and Equity, Role of the Government, Arrow's Theorem, General equilibrium Under Uncertainty. **Module 2: Asymmetric Information** Symmetric & Asymmetric Information, Adverse Selection, Signaling, Screening, The Principal-Agent Problem, Hidden actions- Moral hazard, Hidden information, Market Power from Price Ignorance. **Module 3: Externalities, Open-Access and Public Goods** Externalities and Inefficiencies, The Inefficiency of Competition with Externalities, Regulating Externalities, Market Structure and Externalities, Allocating Property Rights to Reduce Externalities - Coase Theorem, Rivalry and Exclusion. **Module 4: Game Theory- Basic notions** Static Games, Normal-Form Games, Predicting a Game's Outcome, Multiple Nash Equilibria, No Nash Equilibrium, and Mixed Strategies, Repeated Dynamic Games, Strategies and Actions in Dynamic	12 hours 12 hours 12 hours 12 hours

	Games, Cooperation in a Repeated Prisoner's Dilemma Game, Sequential Dynamic Games, Game Tree, Subgame Perfect Nash Equilibrium, Credibility Dynamic Entry Game, Auctions, Behavioral Game Theory.	
Pedagogy:	• Chalk and talk aided by ICT enabled lectures • PC lab exercises • Assignments and presentations • Group activity • MOOC (or similar) Component	
Reference/ Readings:	**Core reading:** 1. Andreu Mas-colell, Michael D. Whinston and Jerry R. Green John, Microeconomic Theory, Oxford University Press India, First Edition (2012). **Additional reading:** 1. Jeffery M. Perloff, Microeconomics, Pearson Education, Ninth Edition. 2. Drew Fudenberg and Jean Tirole, Game Theory, MIT Press. 3. Geoffry A. Jehle and Philip J. Reny, Advanced Microeconomic Theory, Pearson Education, Third Edition.	
Course Outcomes:	At the end of the course, the students will be able to - 1. Solve and interpret problems based on microeconomic models. 2. Use theoretical instruments to coherently analyze various real-world situations. 3. Acquire a strong knowledge base for the study of quantitative issues. 4. Apply the principles of game theory in group dynamics.	

(Back to Index) (Back to Agenda)

Name of the Programme: M.Sc Integrated (Economics)
Course Code: IMC-742
Title of the Course: Indian Public Finance
Number of Credits: 4(4L-0T-0P)
Effective from AY: 2023-24

Prerequisites for the course:	Same as programme requirements	Contact Hours
Objectives:	To familiarise the students with the budgetary process, documents and analyse Government's fiscal policy.	

Content	**Module 1** Government Budget – Meaning and steps involved in the budget formation, Assessment of the Recent Central Government Budget. Fiscal federalism in India - division of function and resources, vertical and horizontal imbalance, devolution of resources from centre to state government, criteria for transfer of resources, and the role of the finance commission. Emerging challenges in India's fiscal federalism **Module 2** Non-tax sources of revenue – types and trends, Taxes – Direct and Indirect taxes, Impact of taxation & tax evasion, Assessment of Indian tax system. Types of public expenditure and its trends, Effects of public expenditure. **Module 3** Deficit Financing - Meaning and Objectives, effects of deficit financing, Trends in different types of deficit finance in India. Public debt - Classifications of public debt, sources and effects of government borrowings, burden and management of public debt. **Module 4** Black Economy – meaning, Measurement, the macroeconomic linkages, causes and consequences of the black economy, and measures undertaken by the government to curb the black economy. Estimates of the black economy in India.	12 Hours 12 Hours 12 Hours 12 Hours
Pedagogy:	● Chalk and talk aided by ICT-enabled lectures ● PC lab exercises ● Assignments and presentations ● Group activity ● MOOC (or similar) Component	
References/ Readings:	**Core Readings** 1. Union Budget, Government of India, Ministry of Finance, New Delhi (various issues) 2. Kumar, A. (2017). The Black Economy in India (Updated Edition). Penguin Random House India, New Delhi **Additional References** 1. Sarma, J. V. M. (2018). Public Finance: Principles and Practices (First edition). Oxford University Press. New Delhi 2. M. Govinda Rao (2022) Studies in Indian Public Finance. Oxford University Press. New Delhi 3. State Finance Report, Reserve Bank of India, Mumbai	
Course Outcomes:	On successful completion, students will be 1. Able to understand the budgetary process in India 2. Able to recognise and analyse the different documents that define the fiscal arm of the government 3. Analyse the government's public policy and its impact on growth and development. 4. Examine the macroeconomic implications of black economy in India	

X AC- 14
13.10.2023

Name of the Programme: M.Sc Integrated (Economics)
Course Code: IMC-743
Title of the Course: Behavioral Economics
Number of Credits: 4(4L-0T-0P)
Effective from AY: 2023-24

Prerequisites for the course:	Same as programme requirements	
Objectives:	To provide students with an understanding of behavioural economics and its tools in economic analysis.	
	Module 1: Introduction to Behavioural Economics History and evolution of behavioural economics. Relationship with other disciplines. Objectives, scope and structure. Methodology – Theories, Evidence, Consilience. Applications of Behavioural Economics. Values, Preferences and Choices – the standard model; axioms, assumptions and definitions; types of utility; neuroscientific basis of utility; policy implications. **Module 2: Essentials of Behavioural Economics** Beliefs, Heuristics and Biases – the standard model, probability estimation. Causes of irrationality. Decision-making under Risk and Uncertainty – Expected Utility Theory and its approaches; prospect theory and loss-aversion. Mental Accounting – nature and policy implications. **Module 3: Intertemporal Choice** Discounted Utility Model – origins, features, methodology and anomalies. Alternative Intertemporal Choice Models – time preference, time inconsistent preferences, hyperbolic discounting, modifying the instantaneous utility function; policy implications. **Module 4: Decision making and Social Preferences** Behavioural Game Theory – nature, equilibrium, strategies, bargaining, iterated games, signalling and learning. Social Preferences – factors affecting social preferences, modelling and models of social preferences (inequality-aversion models and reciprocity models); policy implications.	12 Hours 12 Hours 12 Hours 12 Hours
Pedagogy	● Chalk and talk aided by ICT-enabled lectures ● PC lab exercises ● Assignments and presentations ● Group activity ● MOOC (or similar) Component	
Reference/	Core Reading	

Readings	1. Wilkinson, N., & Klaes, M. (2017). An introduction to behavioral economics. Bloomsbury Publishing. Additional Reading 1. Camerer, C. F., Loewenstein, G., & Rabin, M. (Eds.). (2004). Advances in behavioral economics. Princeton university press.	
Course Outcomes	The students will be able to: 1. Connect how human psychology influences economic choices. 2. Evaluate how decisions are made under uncertainty 3. Assess how intertemporal choices are undertaken 4. Explain how social preferences influence decision making	

(Back to Index) (Back to Agenda)

Name of the Programme: M.Sc Integrated (Economics)
Course Code: IMC-744
Title of the Course: Health Economics
Number of Credits: 4(4L-0T-0P)
Effective from AY: 2023-24

Prerequisites for the course:	Same as programme requirements	Contact Hours
Objectives:	Provide an understanding of health as human capital and recognise how healthcare markets differ from other conventional markets.	
Content	**Module 1** **Economic Development and Health** Meaning, Relevance and Scope of Health Economics, General problems of Resource allocation in the health care sector. Need versus demand. The demand for health as human capital. Models of demand – Grossman model and Components of costs. Supplier-induced demand. Role of pharmaceutical and medical equipment industries on demand. **Module 2** **Quality of Healthcare** Measurement of quality of care, Measurement of health state utilities - rating scales, standard gamble, and time trade-off; QALYs and its alternatives- different approaches of valuing health, Multi-attribute utility instruments and their development. **Module 3** **Healthcare in India** National Health Policy – objectives and features, Different types of healthcare systems and Issues in Healthcare Delivery System, Demand and supply of healthcare in India, Share of GDP. **Module 4** **National Health Accounts:** Capital Health Expenditures, Current Health expenditure - healthcare financing schemes, Revenues of healthcare	12 Hours 12 Hours 12 Hours 12 Hours

	financing schemes, Healthcare providers and Healthcare Functions, Health Service Utilisation and Out of pocket expenditures.	
Pedagogy:	● Chalk and talk aided by ICT-enabled lectures ● PC lab exercises ● Assignments and presentations ● Group activity ● MOOC (or similar) Component	
References/ Readings:	**Core Readings** 1. Bhattacharya, J., Hyde, T., & Tu, P. (2013). Health Economics. Palgrave Macmillan. 2. Zweifel, P., Breyer, F., & Kifmann, M. (2009). Health Economics. Springer Berlin Heidelberg. **Additional Readings** 1. Phelps, C. E. (2017). Health Economics (6th edition). Routledge. 2. McPake, B., & Normand, C. (n.d.). Health Economics: An International Perspective, Second Edition. 313. 3. Shirley Johnson Lans, 2005. A Health Economics Primer, Pearson Addison Wesley, New York 4. McPake Barbara, Kumarnayake Lilani and Normand Charles, 2008. Health Economics: An International Perspective. Second Edition Routledge, London. 5. Donaldson Cam and Karen Gerard 2004, Economics of health care financing: the visible hand, Palgrave Macmillan. New York.	
Course Outcomes:	After completing the course, the students will acquire the ability to: 1. Assess linkages between health and development 2. Comprehend the measures of quality and utility of health care 3. Describe healthcare delivery issues in India 4. Interpret the National Health Accounts	

(Back to Index) (Back to Agenda)

Name of the Programme: M.Sc Integrated (Economics)
Course Code: IMC-841
Title of the Course: Advanced Macroeconomics
Number of Credits: 4(4L-0T-0P)
Effective from AY: 2023-24

Prerequisites for the course:	Same as programme requirements	
Objectives:	To understand the role of monetary and fiscal policy in determining output, interest rates and exchange rate.	

	Module 1: Aggregate demand and supply Aggregate Demand curve, AD-AS equilibrium in the Keynesian case, AD and the mistaken expectations aggregate supply, policy lags, real business cycle, Shrinking and efficiency wages, the long run and staggered wage setting, insider-outsider approach. **Module 2: Mundell Fleming model** Accounting for an open economy, capital mobility and balance of payments, monetary and fiscal policy under flexible exchange rate, monetary and fiscal policy under fixed exchange rate, capital flows and macro policy, limits to discretionary policy, **Module 3: Monetary policy and objectives and targets and growth model.** Goals of monetary policy and intermediate targets, choosing intermediate targets in the case of demand and money shocks, targeting nominal GDP, rules versus discretion in the monetary policy. **Module 4: Growth model** Sources of growth, potential and feasible output, determination of long term growth, Solow model- comparative statistics, the golden rule, convergence , poverty traps, endogenous growth model	12 Hours 12 Hours 12 Hours 12 Hours
Pedagogy:	● Chalk and talk aided by ICT enabled lectures ● PC lab exercises ● Assignments and presentations ● Group activity ● MOOC (or similar) Component	
References/Readings	**Core Reading** 1. Errol D'Souza, Macroeconomics, Pearson Education, Delhi Second Edition 2012 **Additional Reading** 1. Richard T. Froyen, Macroeconomics: Theories and Policies, Pearson Education, 10th Edition or later, 2013. 2. Romer David, Advanced Macroeconomics, McGraw-Hill Education.	
Learning Outcomes	Students will be able to 1. Analyze the relationships between monetary and fiscal policy on aggregate income, interest rate and exchange rate 2. Predict consequences of fiscal and monetary policy in a closed and open economy 3. Examine the implications of the monetary policy 4. Describe the theoretical framework of growth models	

(Back to Index) (Back to Agenda)

X AC- 14
13.10.2023

Name of the Programme: M.Sc Integrated (Economics)
Course Code: IMC-842
Title of the Course: International Finance
Number of Credits: 4(4L-0T-0P)
Effective from AY: 2023-24

Prerequisites for the course:	Same as programme requirements	
Objective:	To introduce students to global financial markets in relation to domestic policies and regulatory systems.	Hours Per Module
Content:	**Module-1.** BOP adjustment Balance of payments (BOP) accounts and balances BOP and National Income-Foreign trade multiplier-BOP adjustments- Elasticity's approach-Marshall-Lerner condition, J curve-Absorption approach-Internal balance and external balance-Assignment Problem.	12 Hours
	Module-2. Exchange Rate Foreign exchange market--Exchange rate determination-Spot markets- Forward markets-Interest arbitrage-Covered uncovered-Hedgers-Speculators-Theories of exchange rate determination-Purchasing power parity-Monetary model Flexi-price-Sticky price-Exchange rate overshooting-Portfolio balance model.	12 Hours
	Module-3. Currency Futures, Options & Swaps Futures market - Hedging - Options market-Call option-Put option-Option premium-Option pricing model-Foreign exchange risk-Exchange rate systems-Currency Swaps.	12 Hours
	Module-4. International Money and Capital Market Eurocurrency market-Characteristics- loan syndication technique- Capital market-International bond market-Equity market-GDRs-ADRs. International Liquidity Bretton Woods system & its collapse -managed floating Optimum currency areas.	12 Hours
Pedagogy:	• Chalk and talk aided by ICT enabled lectures • PC lab exercises • Assignments and presentations • Group activity • MOOC (or similar) Component	
References/Readings	**Core Reading** 1. Pilbeam. K (2009) International Finance, Palgrave Macmillan, New York. 2. Feenstra, Robert and Alan Taylor(2008) International Economics, Worth Publishers, New York. **Additional Reading** 1. Gandolfo Giancarlo,(2006), International Finance and Open - Economy Macro Economics, Springer, New York. 2. Husted Steven and Michel Melvin(2009), International Economics, Addison-Wesley, New York. 3. Kenen Peter B(2000), International Economy, Cambridge University	

	Press, New York. 4. Krugman, Paul and Maurice Obstfeld (2009),International Economics: Theory and Policy Pearson Education, Addison Wesley Longman, New Delhi. 5. Levi, M.D (2005) International Finance, Routledge, Taylor Francis Group, New York · London 6. Salvatore Domnic(2007), International economics, Macmillan, London. 7. Shapiro Alan, C (1999),Multinational Financial Management, John Wiley , New York. 8. Sodersten Bo and Geoffery Reed (1994), International Economics, Macmillan Press,	
Learning Outcomes	Upon successful completion of the course, students will be able to: 1. Understand the structure and pattern of international financial transactions based on the theories 2. Understand the role of international finance in economic development 3. Know the functioning of the international financial system 4. Role and function of international institutions shaping international trade and finance.	

(Back to Index) (Back to Agenda)

Name of the Programme: M.Sc Integrated (Economics)
Course Code: IMC-843
Title of the Course: Theories of Economic Growth
Number of Credits: 4(4L-0T-0P)
Effective from AY: 2023-24

Prerequisites for the course:	Same as programme requirements	Contact Hours
Objectives:	To introduce students to the theories and empirics of growth	
Content	**Module 1** Economic growth and development– meaning, Criteria of measurements Structural characteristics of developing countries – demographic, occupational and production, rural-urban migration. Agrarian change and industrial transformation, Post-industrial society. **Module 2** Rostow's Stages of Growth- Big Push- Balanced and Unbalanced Growth- Critical Minimal Effort- Ranis Fei, Joan Robinson golden age theory **Module 3** **Growth models** Keynesian model: Harrod – Domar growth model, Neo-classical model: Solow's model of economic growth, Convergence – Conditional and Unconditional. Convergence and explaining differences	12 Hours 12 Hours 12 Hours

	in growth rates. **Module 4** **New growth theories** Romer Model, The Final-Goods Sector, The Intermediate-Goods Sector, The Research Sector; Basic Elements of the Schumpeterian Model, Growth in the Schumpeterian Model; The "AK" Model, Externalities and AK Models, Evaluating Endogenous Growth Models	12 Hours
Pedagogy:	● Chalk and talk aided by ICT-enabled lectures ● PC lab exercises ● Assignments and presentations ● Group activity ● MOOC (or similar) Component	
References/ Readings:	**Core Reading** 1. Ray, Debraj, (2010), Development Economics,OUP, Delhi. **Additional References** 1. Cypher, J. M., & Dietz, J. L. (2009). The process of economic development,Routledge, London 2. Jones, C. I., Vollrath, D. (2013). Introduction to Economic Growth. United Kingdom: W.W. Norton.	
Course Outcomes:	Students will be able to 1. Evaluate development and growth processes, especially in developing countries. 2. Explain the transition of economies based on their phase of growth 3. Critically appraise the various Keynesian and Neo-classical models 4. Analyse the endogenous and new growth theories.	

(Back to Index) (Back to Agenda)

Name of the Programme: M.Sc Integrated (Economics)
Course Code: IMC-844
Title of the Course: Information Economics
Number of Credits: 4(4L-0T-0P)
Effective from AY: 2023-24

Prerequisites for the course:	Same as programme requirements	Hours Per Module
Objective:	The course is to introduce students to the effect of asymmetric information on the efficiency properties of market outcomes and the kind of institutions and patterns of behavior develop in response to informational asymmetries.	

Content:	**Module-1** Introduction to Information Economics, Games with incomplete information: Static Bayesian games, Bayesian Nash equilibrium; dynamic Bayesian games, Perfect Bayesian equilibrium and sequential equilibrium **Module-2** The Principal Agent Problem: Hidden actions (Moral hazard) problem, hidden information problems, monopolistic screening . Adverse Selection Concept, lemons problem, game theoretic approach **Module-3** Signaling Separating and Pooling equilibrium, Insurance market, cheap talk Screening Second degree price discrimination (From Tirole, Industrial Organization, Screening in Competitive Insurance Market, Monopoly screening in insurance Market **Module-4** Introduction to Mechanism design Basic concepts, revelation principle, truthful implementation, Groves Clarke mechanisms, Applications of mechanism design to bargaining and auctions Bidding behavior in the four standard auctions: First price sealed bid, second price sealed bid, Dutch auction, English auction. Revenue equivalence theorem.	12 Hours 12 Hours 12 Hours 12 Hours
Pedagogy:	• Chalk and talk aided by ICT enabled lectures • PC lab exercises • Assignments and presentations • Group activity • MOOC (or similar) Component	
References/Readings	**Core Reading** 1. Jehle and Reny (2001), Advanced Micro Economic Theory, Pearson Education Additional reading 1. Mas Collel Whinston and Green (1995), Microeconomic Theory (MWG), Oxford University Press. 2. Kreps A Course in Microeconomic Theory	
Learning Outcomes	Upon successful completion of the course, students will be able to: 1. Economic decision-making process under uncertainty 2. How economic agents make contracts when faced with uncertainty and asymmetric information. 3. Analyze strategic issues faced by for-profit and not-for-profit organizations 4. Illustrate different auction mechanisms	

(Back to Index) (Back to Agenda)

Name of the Programme: M.Sc Integrated (Economics)
Course Code: IMC-941
Title of the Course: Research Methodology
Number of Credits: 4(4L-0T-0P)
Effective from AY: 2023-24

Prerequisites for the course:	Same as programme requirements	
Objective:	Expose students ● to the methodological approaches to research ● Techniques to formulate a research problem ● To Scientific methods for sampling and data collection ● Steps to Writing a research report/thesis/paper	Hours Per Module
Content:	**Module 1** Introduction to Research The meaning of research - types of research - importance of research- research and policy- Deductive and Inductive Reasoning – Steps of scientific methods in research – Qualitative and Quantitative Approach - Mixed Methods. **Module 2** Steps in Research The Research Process: Formulation of a Research problem – Guiding principles in the choice of a Research topic and Formulation of Research Questions –Writing a Proposal - Review of Literature and identification of research gap –Theoretical and Conceptual Framework-Formulation of Research Design – Hypothesis; concept, definition, formulation and testing. **Module 3** Survey-based research Sampling Techniques - field survey - Primary Data Collection - Tools – Observation, Schedule, Questionnaire – principles underlying construction of a questionnaire – data processing and Analysis. Use of statistical software **Module 4** Writing a Research Report Writing a Research report - research paper – Bibliography - reference styles - Ethics in Research - Plagiarism - Writing a thesis - Do's and Dont's.	12 12 12 12
Pedagogy:	• Chalk and talk aided by ICT enabled lectures • PC lab exercises • Assignments and presentations • Group activity • MOOC (or similar) Component	
References/Readings	**Core reading** 1. Kothari C.R., Garg, Gaurav; Research Methodology, Fourth Edition, New Age International, New Delhi, 2020. 2. Wilkinson T.S., and Bhandarkar P.L.: Methodology and Techniques of Social Science Research, Himalaya Publishing House, New Delhi, 2016. 3. Panneerselvam, R., Research Methodology, Prentice Hall of India Pvt Ltd, 2013. **Additional References** 1. Young P.V., Scientific Social Surveys and Research, Prentice Hall of India Pvt Ltd, 2012. 2. Parsons C.J., Thesis and Project Work, Allen &Unwin., 2006. 3. Babbie, Earl. R. 2013. "The Practice of Social Research." Cengage Learning, Canada. 4. John W. Creswell. 2014. "Research Design: Qualitative,	

	Quantitative and Mixed Methods Approaches." Sage Publication, Washington, USA. 5. Kate L. Turabian. 2006. "A Manual for Writers of Term papers, Theses and Dissertations." The University of Chicago press, Chicago. A6. Blaug, Mark. 2009. "The Methodology of Economics." Cambridge University Press, Cambridge. 6. Daniel M. Hausman. 2007. "The Philosophy of Economics: An Anthology." Cambridge University Press, Cambridge	
Learning Outcomes	Upon successful completion of the course, students will be able to: 1. Differentiate the use of various research methods and techniques. 2. Define a research problem and prepare the appropriate research design for the research problem. 3. Demonstrate the sampling techniques and illustrate the data collection techniques and data analysis and presentation. 4. Undertake the task of interpretation and the art of writing research reports.	

(Back to Index) (Back to Agenda)

Name of the Programme: M.Sc Integrated (Economics)
Course Code: IMC-942
Title of the Course: Data Sources for the Indian Economy
Number of Credits: 4(4L-0T-0P)
Effective from AY: 2023-24

Prerequisites for the course:	Same as programme requirements	
Objectives:	To learn the different sources of data available in the public domain both in India and globally. This will cover different domains of data requirements for economics research. Students would learn the extent and limitations of different data sources.	
Content:	**Module I** **Macroeconomic Data Source** Sources of the Government of India – Ministry of Finance, Reserve Bank of India, Niti Ayog Sources of Multilateral agencies – World Bank, International Financial Statistics, United Nations Private Sources – CMIE, EPWRF	12 hours
	Module II **Microeconomic Data Sources** (including Demography, Labour, Agriculture and Industry) Sources of the Government of India – National Sample Organisation (NSSO data), Ministries of GoI, Census of India, Annual Survey of Industries, NFHS Sources of Multilateral agencies – Living Standards	12 hours

	Private Sources – CMIE, IHDS, NCAER, IIPS, EPWRF	
	Module III **International Trade Data Sources** Sources of the Government of India – Government of India (DGCIS, Ministry of Commerce, RBI) Sources of Multilateral agencies – United Nations (COMTRADE, WITS, UNCTAD, UNEP), World Bank (WDI), IMF (DOTS), WTO Private Sources – CMIE, EPWRF, WTC, GTAP, CEIC	12 hours
	Module IV **Public Finance, and natural resources** Sources of the Government of India – Finance Commission reports, Budget of the government of India and state governments, MOSPI, MOEFCC, RBI, DPSE Sources of Multilateral agencies – IBRD, UNEP, IPCC Private Sources – CMIE, EPWRF	12 hours
Pedagogy:	• Chalk and talk aided by ICT enabled lectures • PC lab exercises • Assignments and presentations • Group activity • MOOC (or similar) Component	
References/ Readings:	**Core Reading** 1. Handbook of Statistics on Indian Economy, Reserve Bank of India (various years) 2. Economic Survey, Ministry of Finance, Government of India (various years) 3. Handbook of Statistics on Indian States, Reserve Bank of India (various years) 4. Report on Currency and Finance, Reserve Bank of India (various years) **Additional References** 1. NSSO (2001) Concepts and Definitions Used in NSS, National Sample Survey Organisation, Ministry of Statistics & Programme Implementation, Government of India, https://mospi.gov.in/documents/213904/0/concepts_golden.pdf/e98fc072-8660-edd9-f179-ce95674f4ca5?t=1615539414160 2. Egger, Peter and Wolfmayr, Yvonne (2014) What Economists Should Know About International Goods Trade Data, WIFO Working Papers No. 475, Austrian Institute of Economic Research (WIFO), Vienna, https://www.econstor.eu/handle/10419/129020 3. Donaldson,Dave and Adam Storeygard (2014) The View from Above: Applications of Satellite Data in Economics, *Journal Of*	

	Economic Perspectives, 30(4)(pp. 171-98) 4. Auffhammer, Maximilian, Solomon M. Hsiangy, Wolfram Schlenker and Adam Sobelz (2013) Using Weather Data and Climate Model Output in Economic Analyses of Climate Change, *Review of Environmental Economics and Policy*, 7(2), 2013, (pp. 181–198) 5. World Bank (2021) World Development Report 2021 : Data for Better Lives. Washington, DC: World Bank.https://openknowledge.worldbank.org/handle/10986/35218 6. Human Development Report, UNDP (various years) 7. World Trade Statistical Review, WTO (various years)	
Course Outcomes:	Students will know how to 1. Identify potential databases for research 2. Access data from open-domain data sources 3. Understand strengths and weaknesses of different databases 4. Analyse raw data for economic analysis	

(Back to Index) **(Back to Agenda)**

Name of the Programme: M.Sc Integrated (Economics)
Course Code: IMC-943
Title of the Course: Techniques of Geo-Spatial Analysis
Number of Credits: 4(4L-0T-0P)
Effective from AY: 2023-24

Prerequisites for the course:	Basic knowledge of mathematics and statistics as per core requirements in MA Economics	
Objectives:	Understand the use of spatial data and its applications in economics	
Content	**Module 1**: Use of spatial data in economic analysis- Fundamentals of Remote Sensing - Electromagnetic Spectrum, Terms and Units of Measurement, Resolution of a Sensor System,-Spatial, Spectral, Radiometric, Temporal and Angular resolution, sources of information remote sensing data **Module 2:** Raster and Vector Data formats- Interacting with data - identifying features, measuring and selecting data, creating shapefile, snapping, topology, attribute table and filed calculator, data joins, projections, clipping, analyzing elevation, terrain **Module 3:** Interpolation, buffer, Styling layers- raster, terrain, satellite images and landcover map, styling and labeling vector layerspoint, line and polygon style, creating 3D map, print layout map creation, 3D map view. **Module 4:** Analyzing raster data- raster calculator, Combining raster and vector data-converting between raster and vector and zonal statistics, Advanced raster and vector analysis with processing-	12 hours 12 hours 12 hours 12 hours

	Finding nearest neighbors, Converting between points, lines, and polygons.	
Pedagogy:	● Chalk and talk aided by ICT enabled lectures ● PC lab exercises ● Assignments and presentations ● Group activity ● MOOC (or similar) Component	
References/ Readings:	**Core reading** 1. Andrew Cutts, Anita Graser(2018), Learn QGIS, Your Step-by-step Guide to the Fundamental of QGIS 3.4, Packt Publishing,4th Edition, Livery Place, UK. 2. Emilio Chuvieco (2016),Fundamentals of Satellite Remote Sensing An Environmental Approach,CRC Press Taylor & Francis Group 3. Quantum Geographic Information System (QGIS) training manual https://docs.qgis.org/3.10/en/docs/training_manual/index.html **Additional References** 1. Gary E. Sherman(2008), Desktop GIS mapping the planet with open source tools, Pragmatic Bookshelf, Raleigh, North Carolina Dallas, Texas. 2. Otto Huisman, Rolf A. de (2009), Principles of geographic information systems: an introductory textbook, The International Institute for Geo-Information Science and Earth Observation (ITC), Netherlands. 3. Kurt Menke et.al (2016), Mastering QGIS, Packt Publishing, Livery Place, UK. 4. Erik Westra (2014), Building Mapping Applications with QGIS Create Your Own Sophisticated Applications to Analyze and Display Geospatial Information Using QGIS and Python, Packt Publishing,4th Edition, Livery Place, UK. 5. Jay D. Gatrell, Ryan R. Jensen (2009), Planning and Socioeconomic Applications(Geotechnologies and the Environment), Springer Science & Business Media. 6. J. M. Pogodzinski, Richard M. Kos(2013), Economic Development & GIS, Esri Press.	
Course Outcomes:	Candidates will be able to 1. Understand of fundamental of remote sensing and applications of remote sensing and GIS in economics analysis 2. Successfully able to manipulation remote sensing and GIS data 3. Successfully able to use different tools to visualise remote sensing and GIS data 4. successfully able to extract and process spatial data in economic analysis	

(Back to Index) (Back to Agenda)

X AC- 14
13.10.2023

Name of the Programme: M.Sc Integrated (Economics)
Course Code: IMC-944
Title of the Course: Financial Economics
Number of Credits: 4(4L-0T-0P)
Effective from AY: 2023-24

Prerequisites for the Course:	Same as programme requirements	
Objective:	To familiarise the students on the structure, components and mechanism of financial markets.	
Content:	**Module 1:** Significance of Banking, Insurance and Financial Institutions, Structure of the Financial system, Financial Markets and Instruments, Financial Intermediaries, Financial market securities: Equity shares, Bonds and Mutual Funds, Regulating and promotional institutions in Indian Financial system : IRDA, RBI and SEBI **Module 2:** Introduction to Financial Statements, Structure of Financial Statements: Balance Sheet, Income Statement, Statement of Cash Flow. Financial Ratios: Liquidity ratios, Leverage ratios, Turnover ratios, Profitability ratios, Capital Gearing ratios, Limitations. Capital Budgeting Decision of firms, Introduction to risk and risk factors, Measuring investment risks, Diversification, Systematic and idiosyncratic risk. **Module 3:** Discount rates and the Time Value of Money: Present value and Net Present Value, Compound interest, annuity and perpetuity formulas, Real and Nominal cash flows, Bond Valuation and Yield Curve. Asset Pricing Theories and Portfolio Analysis: Mean Variance Portfolio theory, Portfolio Optimization, Single Index Model, Capital Asset Pricing Model, Arbitrage Pricing Theory. **Module 4:** The Derivatives and commodities markets: Forwards and Futures, Spot and Forward prices, Arbitrage, Hedging, Introduction to the Swaps market, Options: Call and Put Options, Pricing of stock options. Role of digital currencies and cryptocurrencies	12 hours 12 hours 12 hours 12 hours
Pedagogy:	● Chalk and talk aided by ICT enabled lectures ● PC lab exercises ● Assignments and presentations ● Group activity ● MOOC (or similar) Component	
Reference/	**Core reading:**	

Readings:	1. R.E. Bailey (2005), *The Economics of Financial Markets*, Cambridge University Press. **Additional reading:** 1. David Luenberger (2013), *Investment Science*, Oxford University Press. 2. Sharpe, W.F., Alexander, G.J. and Bailey, J.F. (2002) *Investments*, Prentice Hall India Pvt. Ltd 3. John C. Hull (2022), *Fundamentals of Futures and Options Markets*, Global Edition, Pearson	
Course Outcomes:	At the end of the course, the students will be able to 1. Describe the financial institutional framework in India 2. Understand the financial ratios, risks and capital budgeting. 3. Apply quantitative techniques to analyse cash flows and understand the principles of financial assets. 4. Evaluate the optimization strategies in the derivatives and crypto-currency markets	

(Back to Index) **(Back to Agenda)**

Annexure III

M.Sc Integrated (Decision Science) **Semester VII onwards specific to the Discipline Decision Science for students opting for MSc Integrated**			
Semester I	**Credits**	**Semester II**	**Credits**
Same as M.Sc Integrated (Data Science)		**Same as M.Sc Integrated (Data Science)**	
Semester III	**Credits**	**Semester IV**	**Credits**
Same as M.Sc Integrated (Data Science)		**Same as M.Sc Integrated (Data Science)**	
Semester V	**Credits**	**Semester VI**	**Credits**
Same as M.Sc Integrated (Data Science)		IMC-631: Financial Management IMC-632: Human Resource Management IMC-633: Ethics and Technology	04 04 04
		Elective 1:list of electives: IMC-610 / IMC- 611 / IMC- 710 to IMC-717	04
		Elective 2:list of electives: IMC-610 / IMC- 611 / IMC- 710 to IMC- 717	04
		Project Work // Internship	06
			26
Semester VII (Discipline:- Decision Science)	**Credits**	**Semester VIII (Discipline:- Decision Science)**	**Credits**
IMC-634: Entrepreneurship IMC-635: Leadership IMC-636: Management Accounting IMC-637: Managerial Decision Making IMC-638: Design Thinking	04 04 04 04 04	IMC-639: Logistics and Supply Chain Management IMC-640: Production and Operations Analytics IMC-641: Forecasting and Analytics	06 06 04
Elective 3: list of electives: IMC- 610 / IMC- 611 / IMC -704/IMC- 710 to IMC- 717	04	**Elective 4**: list of electives: IMC-610 / IMC- 611 / IMC -704/IMC-710 to IMC- 717/IMC-801 to IMC-802	04
		Elective 5: list of electives: IMC-	04

		610 / IMC- 611 / IMC -704/IMC-710 to IMC- 717/IMC-801 to IMC-802	
	24		**24**
Semester IX (Discipline:- Decision Science)	**Credits**	**Semester X (Discipline:- Decision Science)**	**Credits**
Elective 6: IMC -701 to IMC-704/IMC-801 to IMC-802/	04	**Dissertation// Internship**	16
Elective 7: IMC-642/IMC-742/IMC-743/IMC-842	04		
Elective 8: IMC-642/IMC-742/IMC-743/IMC-842/ IMC-944	04		
Elective 9: IMC-642:Human Resource Analytics/IMC-643:Financial Modeling/IMC-644:Marketing Research	04		
	16		16

(Back to Index) (Back to Agenda)

Programme: MSc (Decision Sciences)
Course Code: IMC-631
Title of Course: Financial Management
Number of Credits: 4 (4L-0T-0P)
Effective from AY: 2023-24

Prerequisites for the course:	NIL	
Objective:	To introduce fundamentals of financial management for basic financial decision making.	

Content:	**Unit I:** **Elementary Analysis of Annual Reports** Concepts and Conventions of Accounting, Reading of Annual Report, Balance Sheet, Profit and Loss Account, Vertical Form, Cash Flow statements. **Unit II:** **Analysis of Financial Statements** Comparative statements, Common Size Statements, Profitability Ratios, Basic Accounting Standards, Directors' Report, Auditor's Report, Notes to Accounts, Understanding Annual Reports of Companies with Ratio Analyses. **Unit III:** **Capital Budgeting Decisions** Scope of Financial Management, Creating Shareholder Value, Agency Issues, Time Value of Money, Forecasting cash flows, Estimation of Project Cost, Techniques of Capital Budgeting: Net Present Value, Internal Rate of Return, Discounted Payback, Profitability Index, Cost of Capital: Meaning and Concept, Calculation of Weighted Average Cost of Capital, Capital Structure and Leverage: concept. **Unit IV:** **Working Capital Management** Basics of Working Capital, Operating cycle, Estimation of Working Capital, Components of Working Capital, namely, Cash, Inventory and Debtors, Sources of Long term and Short term finance.	12 hours 12 hours 12 hours 15 hours
Pedagogy:	Lectures/ tutorials/laboratory work/ field work/ outreach activities/ project work/ vocational training/viva/ seminars/ term papers/assignments/ presentations/ self-study/ 6Case Studies etc. or a combination of some of these. Sessions shall be interactive in nature to enable peer group learning.	
Learning Outcomes:	At the end of this course, the participants will be able to: • Analyse financial information that facilitates long term and short term financial decisions.	
References/Readings:	1. N. Ramchandran, Ram Kumar Kakani; Financial Accounting for Management**,** Tata McGraw-Hill Pvt Ltd: Latest edition 2. Bhattacharyya, S. K. And John Dearden; Accounting for Management, Vikas Publishing House Pvt. Ltd.; New Delhi; Latest Edition 3. Chandra, Prasanna; Financial Management: Theory and Practice; Tata McGraw-Hill; Latest Edition. 4. Pandey, I.M. and Ramesh Bhat; Cases in Financial Management; Tata McGraw-Hill; Latest Edition. 5. Pandey, I.M; Financial Management; Vikas Publishing House Pvt. Ltd. Noida UP; Latest Edition.	

(Back to Index) (Back to Agenda)

X AC- 14
13.10.2023

Programme: MSc (Decision Sciences)
Course Code: IMC-632
Title of Course: Human Resource Management
Number of Credits: 4 (4L-0T-0P)
Effective from AY: 2023-24

Prerequisites for the course:	NIL	
Objective:	To understand the Human Resource practices of a firm.	
Content:	**Unit I:** **Fundamentals of HR Management** Concepts and Perspectives, Corporate objectives and challenges of HR, Job Analysis: Job description and Job Specifications, Human Resource Planning: Demand and Supply, Downsizing and Retention. **Unit II:** **Human Resource Functions** Recruitment and Selection, Compensation and Reward Management: Job Evaluation, methods and types of compensation, Performance Management, Potential assessment and Competency development, Training and Development: Training process and methods. **Unit III:** **Employee Relations and Trade Unions** Trade Union movement and status in India, Politics and Unions, Negotiations, Grievance Redressal, Dispute Resolution and Conflict Management, Employee Empowerment, Employee health orientation and managing Sickness/Absenteeism at workplace. **Unit IV:** **Organizational strategy** Structure, culture and change, and their implications for HRM, Technology in HR, Green HRM and Sustainability, Introduction to International HRM .	12 hours 12 hours 12 hours 12 hours
Pedagogy:	Lectures/ tutorials/laboratory work/ field work/ outreach activities/ project work/ vocational training/viva/ seminars/ term papers/assignments/ presentations/ self-study/ Case Studies etc. or a combination of some of these. Sessions shall be interactive in nature to enable peer group learning.	
Learning Outcomes:	At the end of this course, the participants will be able to: • Take basic decisions in Human Resource Management.	
References/Readings:	1. Ca Noe R A; Hollenbeck JR, Gerhart B and Wright P M; Human Resource Management – Gaining a competitive advantage, McGraw Hill, Latest Edition. 2. Dessler, Gary; A Framework for Human Resource Management, Pearson Education India, Latest Edition. 3. Armstrong M, Taylor S; Armstrong's Handbook of Human Resource Management Practice, Kogan Page, Latest Edition.	

(Back to Index) (Back to Agenda)

Programme: MSc (Decision Sciences)
Course Code: IMC-633
Title of Course: Ethics and Technology
Number of Credits: 4 (4L-0T-0P)
Effective from AY: 2023-24

Prerequisites for the course	**NIL**	
Objectives:	A comprehensive understanding of the importance of ethics and ethical practices in technology based organisations.	
Content:	**Unit I:** Introduction to Business Ethics; Need of Ethics in the domain of Technology; Individuals, Technology & Society -The Digital Divide: Information Technologies and the Obligation to Alleviate Poverty; Objectivity in Science. **Unit II:** Technology and Innovation; Information Technology and its common concerns; Values involved in Technology – External and Internal Values. **Unit III:** Applying Ethics in Technological Developments; Safety, Health, and Welfare: Risk and Unintended Consequences; Surveillance & Privacy; Transhumanism; Big Data and Algorithmic Bias. **Unit IV:** Ethical Concerns in different Technological fields - Biomedical Technology; Environmental and Agricultural Technology; Artificial Intelligence and Robotics; Cryptocurrency; Automated vehicles; Ethics in Research in Technology.	12 hours 12 hours 12 hours 12 hours
Pedagogy:	Lectures/Tutorials/Laboratory Work/ Field Work/ Outreach Activities/ Project Work/ Vocational Training/Viva/ Seminars/Term Papers/Assignments/ Presentations/ Self-Study/ Case Studies Etc. or a Combination of Some of these. Sessions shall be Interactive in nature to enable Peer Group Learning.	
References/ Readings:	1. Ronald L. Sandler ed; Ethics and Emerging Technologies, Palgrave Macmillan, 2013 or Latest Edition. 2. Morton Winston and Ralph Edelbach eds; Society, Ethics, and Technology, Cengage Learning, 2013 or Latest Edition. 3. Sheila Jasanoff; The Ethics of Invention: Technology and the Human Future, W. W. Norton & Company, 2016 or Latest Edition.	
Learning Outcomes:	At the end of this course, the participants will be able to: ● Make ethical choices when working with technology	

(Back to Index) (Back to Agenda)

X AC- 14
13.10.2023

Programme: MSc (Decision Sciences)
Course Code: IMC-634
Title of Course: Entrepreneurship
Number of Credits: 4 (4L-0T-0P)
Effective from AY: 2023-24

Prerequisites for the course:	**NIL**	
Objective:	Introduce the concepts of entrepreneurship and the essentials of starting new ventures.	
Contents:	**Unit I:** **Basics of Entrepreneurship** Concept, knowledge and skills requirement, characteristic of successful entrepreneurs, role of entrepreneurship in economic development, entrepreneurship process, factors impacting emergence of entrepreneurship, Different forms of businesses. **Unit II:** **Starting the venture** Opportunity Recognition and Analysis, Gathering the Resources, generating business ideas, creative problem solving, competitor and industry analysis; feasibility study: market feasibility, technical/operational feasibility, financial feasibility, Business plan: preparing project report, presenting to investors. **Unit III:** **Functional plans** Marketing plan: marketing research, preparing marketing plan, contingency planning, organizational plan: form of ownership, designing organization structure, job design, manpower planning, Financial plan: cash budget, working capital, income statements, Cash flows, Balance sheet, break even analysis, Human Resource Plan: Recruitment, Selection, Staffing, Training and Development; Compensation, Performance Management, Operational Plans: Managing materials, use of Technology. **Unit IV:** **Sources of finance & Legal Issues** Debt or equity financing, Commercial banks, Venture capital, development financial institutions, legal issues: intellectual property rights: patents, trademarks, copy rights, trade secrets, licensing, franchising, Developing Entrepreneurial Marketing: Competencies, Networks, Rural Entrepreneurship, Social Entrepreneurship, Intrapreneurship.	12 hours 12 hours 12 hours 12 hours
Pedagogy:	Lectures/ tutorials/laboratory work/ field work/ outreach activities/ project work/ vocational training/viva/ seminars/ term papers/assignments/ presentations/ self-study/ Case Studies etc. or a combination of some of these. Sessions shall be interactive in nature to enable peer group learning.	

Learning Outcomes:	At the end of this course, the participants will be able to: • Create new ventures and understand their managerial requirements.	
References/Readings:	1. RD Hisrich, MP Peters and DA Shepherd; Entrepreneurship, Tata McGraw Hill Publishing, Latest Edition. 2. S.Bhargava; Entrepreneurial Management, Response Books, Sage Publishing, Latest Edition. 3. P Tiffany & SD Peterson; Business Plans for Dummies, Wiley India, Latest Edition. 4. G Friend & S Zehle; Guide to Business Planning, The Economist publication, Latest Edition.	

(Back to Index) (Back to Agenda)

Programme: MSc (Decision Sciences)
Course Code: IMC-635
Title of Course: Leadership
Number of Credits: 4 (4L-0T-0P)
Effective from AY: 2023-24

Prerequisites for the course:	**NIL**	
Objective:	Introduce the concepts of leadership and developing leaders at work-place.	
Contents:	**Unit I:** **Introduction to Leadership** Leadership and Person, Personality, cultural values and ability, Leadership that gets results, Emotional Intelligence, Models of Leadership, Leadership theories: Traits, Situational, and Functional leadership, Leadership and Power, Leadership and Influence: Interpersonal Conflict and Negotiation, Leadership in Groups and Teams. **Unit II:** **Leadership and Organisation** Organizations as Complex Systems: Strategy, Structure & Environment, Organizational Culture, Leading Teams: Design and Structure, Leadership and Communication, Leading Change. **Unit III:** **Leadership Development** Identifying potential leaders, Leader Development Vs Leadership Development, Process of leadership Development, Developmental Readiness of employees, Tools and interventions for developing leadership. **Unit IV:** **Special Leadership dimensions** Identifying potential dark/ Negative leadership, Corrective measures, Public Leadership, Academic Leadership, Spiritual Leadership, Transformational leadership, Leadership in different types of organisations: Small businesses, Family Businesses, Global Organisations.	12 hours 12 hours 12 hours 12 hours

Pedagogy:	lectures/ tutorials/laboratory work/ field work/ outreach activities/ project work/ vocational training/viva/ seminars/ term papers/assignments/ presentations/ self-study/ Case Studies etc. or a combination of some of these. Sessions shall be interactive in nature to enable peer group learning.	
Learning Outcomes:	At the end of this course, the participants will be able to: • An effective leaders and to promote leadership among others at workplace.	
References/Readings:	1. RL Hughes, RC Ginnett, GJ Curphy; Leadership; Tata McGraw Hill; 2022 or Latest Edition. 2. James Kouzes, Barry Posner, Jossey-Bass; The Leadership Challenge; 2002 or Latest Edition. 3. J Owen, Kogan; The Leadership Skills Handbook; Page Publishing;2020 or Latest Edition. 4. WG Rowe, L Guerrero; Cases in Leadership;Sage Publications; 2015 or Latest Edition. 5. JH Zenger, JR Folkman; The Extra ordinary Leader;Tata McGraw Hill; 2002 or Latest Edition.	

(Back to Index) (Back to Agenda)

Programme: MSc (Decision Sciences)
Course Code: IMC-636
Title of Course: Management Accounting
Number of Credits: 4 (4L-0T-0P)
Effective from AY: 2023-24

Prerequisites for the course:	**NIL**	
Objective:	Introduce Cost Concepts that are used in an organisation to facilitate cost management.	

Content:	**Unit I:** **Cost concepts and Decisions using cost data** Cost concepts, Elements of cost, Cost control, Cost information, Traditional cost management systems, Preparation of cost sheet Cost Volume Profit (CVP)Analysis,Marginal Costing**,** CVP Analysis for managerial decision making, Break Even Point, Margin of Safety, Marginal Costing and Absorption Costing **Unit II:** **Variance Analysis** Direct, Indirect Cost Variance (Material, Labour, Fixed & Variable Overhead Variance, Calendar Variance, Capacity Variance), Revenue & Profit Variance. **Unit III:** **Activity Based Costing (ABC)** Design of traditional Activity Based Cost System, Application of ABC to improve operations, Assign marketing, distribution, and selling expenses to customers, Analyse and manage customer profitability. **Unit IV:** **Budgetary Control and Performance Evaluation** Introduction – Definition – Budget – Budgeting – Budget Control – Characteristics -Meaning – Objectives – Requisites – Advantages – limitations – Steps involved in Budgetary Control - Essentials – Advantages – Budgetary Control Vs Standard Costing - Classification of Budgets – Functional Budgets – Sales Budget – Production Budget – Direct Material Budget – Direct Labor Budget – Manufacturing Overhead Budget – Capital Expenditure Budget – Cash Budget – Master Budget – Flexible Budget – Zero Based Budgeting.	12 hours 12 hours 12 hours 12 hours
Pedagogy:	Lectures/ tutorials/laboratory work/ field work/ outreach activities/ project work/ vocational training/viva/ seminars/ term papers/assignments/ presentations/ self-study/ Case Studies etc. or a combination of some of these. Sessions shall be interactive in nature to enable peer group learning.	
Learning Outcomes:	At the end of this course, the participants will be able to: • Take managerial decisions considering the impact of costs on the operations of an organisation.	

References/Readings:	1. Anthony Atkinson, Robert Kaplan, Ella Mae Matsumura, S. Mark Young, G. Arun Kumar; Management Accounting; Pearson Education Publication;2011 or Latest Edition. 2. William Lanen, Shannon Anderson & Michael Maher; Fundamentals of Cost Accounting; Tata McGraw Hill Publication;2022 or Latest Edition. 3. Satish B. Mathur, Accounting for Management, McGraw Hill Publication, 2010 or Latest Edition. 4. Khan M. & Jain P., Management Accounting, McGraw Hill Education; 2017 or Latest Edition. 5. Hansen Don &Mowen Maryanne, Management Accounting, South-Western/Thomson Learning; 2007 or Latest Edition. 6. Coombs Hugh, Hobbs David and Jenkins Ellis, Management Accounting: Principles and Applications, SAGE Publications Ltd; 2005 or Latest Edition.	

(Back to Index) (Back to Agenda)

Programme: MSc (Decision Sciences)
Course Code: IMC-637
Title of Course: Managerial Decision Making
Number of Credits: 4 (4L-0T-0P)
Effective from AY: 2023-24

Prerequisites for the course:	**NIL**	
Objective:	To introduces the participants to the methodology as well as to the major models used for decision making.	

Content:	**Unit I:** The Fundamentals of Operations Research: Introduction to management Science; The methodology of Decision Making; Models in Managerial Decision Making Linear Programming (LP): Introduction; Characteristics of LP Problems; Graphical solution of a LP problems; A Maximization Problem; a Minimization Problems; Problems General Formulation and Assumptions of LP problems **Unit II:** Sensitivity analysis in Linear Programming: Dual Prices in LP; Reduced costs in LP; Changes in the Objective Function's Coefficients; Changes in the Right Hand Sides (RHS) of the Constraints; Evaluation of a New Activity Using Solver to Solve Linear Programming Problems: Introducing the model in Excel; Solving the Problem; Understanding and Analyzing the Solution – SOLVER Reports. **Unit III:** Integer Programming (IP): Introduction; Formulating IP Problems with Binary Variables; Formulating IP Problems; Solving IP problems; Solving Integer Programming Problems withSOLVER. Implementing Management Science in Practice: Marketing and Sales problems; Production and Inventory problems; Networks and Transportation problems; Logistics and Supply Chain problems; Investments problems; Human Resources problems. **Unit IV:** Decision Analysis and Precision Tree: Introduction; Criteria for Making Decision under Uncertainly; The Expected Value of Perfect Information; Decision Tree; Calculating the Risk Profile a Strategy; Sensitivity Analysis; Using Precision Tree to Solve Decision Analysis Problems. Simulation: Introduction; Implementation of Simulation under Conditions of Uncertainty Using Excel and @Risk in Simulation: Introduction; Simulation of Queuing Systems; Simulation of an Inventory System; Analysis of Simulation Results.	12 hours 12 hours 12 hours 12 hours
Pedagogy:	Lectures/ tutorials/laboratory work/ field work/ outreach activities/ project work/ vocational training/viva/ seminars/ term papers/assignments/ presentations/ self-study/ Case Studies etc. or a combination of some of these. Sessions shall be interactive in nature to enable peer group learning.	
Learning Outcomes:	At the end of this course, the participants will be able to: • Understand and formulate decision making problems, and to use the computer technology efficiently in order to make the best decision.	

References/Readings:	1. G. P. Prastacos; Managerial Decision Making Theory and Practice, Tsinghua University Press, Latest Edition. 2. N.B Alakrishnan, B. Render, and R. M. Stair, Jr.; Managerial Decision Modeling with Spreadsheets, Pearson Education Inc. Latest Edition. 3. C.P. Bonini, W.H. Hausman and H. Bierman; Quantitative Analysis for Management, McGraw-Hill / Irwin, Latest Edition. 4. G. L. Nemhauser and L. A. Wolsey: Integer and Combinatorial Optimization, Wiley Interscience, Latest Edition. 5. W. L. Winston and S.C. Albright: Practical Management Science, South-Western College Pub. Latest Edition.	

(Back to Index) (Back to Agenda)

Programme: MSc (Decision Sciences)
Course Code: IMC-638
Title of Course: Design Thinking
Number of Credits: 4 (4L-0T-0P)
Effective from AY: 2023-24

Prerequisites for the course:	**NIL**	
Objective:	To inculcate the fundamental concepts of design thinking and develop the participants as a good designer by imparting creativity and problem solving ability.	
Content:	**Unit I:** Design Thinking Overview: Design Thinking in the Workplace, Design Thinking Skills and Mindsets, Principles of Design Thinking, Basis and Design Thinking Framework. **Unit II:** Design process: Traditional design, Design thinking, Existing sample design projects, Study on designs around us, Compositions/structure of a design, Innovative design: Breaking of patterns, Reframe existing design problems, Principles of creativity Empathy: Customer Needs, Insight-leaving from the lives of others/standing on the shoes of others, Observation. **Unit III:** Design team-Team formation, Conceptualization: Visual thinking, Drawing/sketching, New concept thinking, Patents and Intellectual Property, Concept Generation Methodologies, Concept Selection, Concept Testing, Opportunity identification Prototyping: Principles of prototyping, Prototyping technologies, Prototype using simple things, Wooden model, Clay model, 3D printing; Experimenting/testing. **Unit IV:** Sustainable product design, Ergonomics, Semantics, Entrepreneurship/business ideas, Product Data Specification, Establishing target specifications, Setting the final specifications. Design projects for teams.	12 hours 12 hours 12 hours 12 hours

Pedagogy:	Lectures/ tutorials/laboratory work/ field work/ outreach activities/ project work/ vocational training/viva/ seminars/ term papers/assignments/ presentations/ self-study/ Case Studies etc. or a combination of some of these. Sessions shall be interactive in nature to enable peer group learning.	
Learning Outcomes:	At the end of this course, the participants will be able to: • Demonstrate the critical theories of design, systems thinking, and design methodologies. • Produce great designs, be a more effective engineer, and communicate with high emotional and intellectual impact. • Understand the diverse methods employed in design thinking and establish a workable design thinking framework to use in their practices. • Conceive, organize, lead and implement projects in interdisciplinary domain and address social concerns with innovative approaches.	
References/Readings:	1. Tim Brown; Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation, Harper Collins Publishers Ltd. Latest Edition. 2. Idris Mootee; Design Thinking for Strategic Innovation, John Wiley & Sons Inc., Latest Edition. 3. Brenda Laurel Design Research methods and perspectives MIT press, Latest Edition. 4. Terwiesch, C. & Ulrich, K.T.; Innovation Tournaments: creating and identifying Exceptional Opportunities, Harvard business press, Latest Edition. 5. Ulrich & Eppinger; Product Design and Development, McGraw Hill, Latest Edition. 6. Stuart Pugh; Total Design: Integrated Methods for Successful Product Engineering, Bjarki Hallgrimsson, Prototyping and model making for product design, Laurence King Publishing Ltd. Latest Edition. 7. Kevin Henry; Drawing for Product designers, Laurence King Publishing Ltd. Latest Edition.	

(Back to Index) (Back to Agenda)

Programme: MSc (Integrated)
Course Code: IMC-639
Title of Course: Logistics and Supply Chain Management
Number of Credits: 6 (6L-0T-0P)
Effective from AY: 2023-24

Prerequisite for the course	**NIL**	
Objective:	To enable the participants to understand supply chain dynamics and manage logistics and supply chain networks.	
Content:	**Unit I:** Supply Chain Management - Introduction and Global Dimensions,	12 hours

	Logistics, Supply Chain, Supply Networks and Design. **Unit II:** Demand Management and Production Orders, Supply Logistics and Customers Service. **Unit III:** Sourcing Materials and Services, Inventory, Role and Functions. **Unit IV:** Management of Distribution and Transportation. **Unit V:** Supply Chain Management Alignment, Performance Measurement and Financial Analysis. **Unit VI:** Strategic Supply Chain Management, Technology and Information Flows.	12 hours 12 hours 12 hours 12 hours 12 hours
Pedagogy:	Lectures/ tutorials/laboratory work/ field work/ outreach activities/ project work/ vocational training/viva/ seminars/ term papers/assignments/ presentations/ self-study/ Case Studies etc. or a combination of some of these. Sessions shall be interactive in nature to enable peer group learning.	
References/ Readings:	1. John Langley, Jr. | Robert A. Novack | Brian J. Gibson | John J. Coyle; Supply Chain Management: A Logistics Perspective, Cengage, 2021 or Latest Edition. 2. David Simchi-Levi | Edith Simchi-Levi | Philip Kaminsky | Ravi Shankar; Designing & Managing the Supply Chain, Mc Graw Hill, 2022 or Latest Edition. 3. David A. Collier | James R. Evans; OM Operations + Supply Chain Management, Cengage, 2020 or Latest Edition.	
Learning Outcomes:	At the end of the course, the participants will be able to: • Identify supply chain networks. • Identify logistics networks. • Manage inventory processes. • Analyse strategic supply chain performance.	

(Back to Index) (Back to Agenda)

Programme: MSc (Decision Sciences)
Course Code: IMC-640
Title of Course: Production and Operations Analytics
Number of Credits: 6 (6L-0T-0P)
Effective from AY: 2023-24

Prerequisites for the course:	**Basics of production and operations management**	
Objective:	This course aims to equip participants to apply production and operations decision-making tools.	

Content:	**Unit I:** **Introduction** Operations Strategy, Strategic initiatives: reengineering, just-in-time, time-based competition, competing on quality, servicization, Process and product life cycle matching, learning and experience curves, capacity growth planning, Forecasting methods and manufacturing: forecasting stationary series, trend-based methods, seasonal series methods, Box-Jenkings models, simulation.	12 hours
	Unit II: **Sales & Operations Planning (S&OP) and Linear Programming** S&OP process, key performance indicators, aggregate capacity planning, solving aggregate planning problems, disaggregating plans, solving linear programming problems, the simplex method, sensitivity report. Service operations management: Service operations strategy, flow systems, modeling unscheduled arrivals, queueing systems, general queueing models, queueing techniques, revenue management.	12 hours
	Unit III: **Inventory control and supply chain management** Types of inventories, inventory systems, relevant inventory costs, the EOQ model, quantity discount models, EOQ models for production planning, optimization criterion, the newsvendor model, lot size-reorder point systems, service levels in (Q, R) systems, periodic review systems, multiproduct systems, supply chain strategy, the transportation problem.	12 hours
	Unit IV: **Production control systems, layout and location** Material Requirements Planning, Just in Time, the explosion calculus, alternative lot-sizing schemes, lot sizing algorithms and explosion calculus, lot sizing with capacity constraints, facilities layout problem, layout techniques, flexible manufacturing systems, locating new facilities and associated problems.	12 hours
	Unit V: **Operations and project scheduling** Job shop scheduling problems, comparison of specific sequencing rules, sequencing theory for a single machine, sequencing algorithms for multiple machines, stochastic scheduling, assembly line balancing, critical path analysis with linear programming, time costing methods, project evaluation and review technique, issues in project management.	12 hours
	Unit VI: **Quality, reliability and maintainability** Statistical methods and control charts, acceptance sampling, single & double sampling for attributes, sequential sampling plans, average outgoing quality, total quality management, component reliability, reliability modeling, complex equipment failures, maintenance models, replacement strategies, analysis of warranty policies.	12 hours
Pedagogy:	Lectures/ tutorials/laboratory work/ field work/ outreach activities/ project work/ vocational training/viva/ seminars/ term	

	papers/assignments/ presentations/ self-study/ Case Studies etc. or a combination of some of these. Sessions shall be interactive in nature to enable peer group learning.	
References/Readings:	1. Steven Nahmias, Tava Olsen; Production and Operations Analytics; Waveland Press Inc; 2021 or Latest Edition. 2. Susmita Bandyopadhyay; Production and Operations Analysis; CRC Press; 2020 or Latest Edition. 3. Lee Krajewski, Manoj Malhotra, Larry Ritzman, Samir Srivastava; Operations Management, Processes and Supply Chains; Pearson; 2019 or Latest Edition.	
Learning Outcomes:	At the end of this course, the participants will be able to: • Comprehend the strategic issues and processes in production and operations planning. • Apply and interpret the techniques for appropriate operations decision-making. • Determine suitable inventory and production control systems. • Design an appropriate framework for operations and project scheduling.	

(Back to Index) (Back to Agenda)

Programme: MSc (Decision Sciences)
Course Code: IMC-641
Title of Course: Forecasting and Analytics
Number of Credits: 4 (4L-0T-0P)
Effective from AY: 2023-24

Prerequisite for the course	**Statistics**	
Objective:	To enable the participants to turn the data into information for decision-making through the use of a forecasting and predictive analytics framework.	
Content:	**Unit I:** **Introduction to Business Forecasting** Forecasting Process, Data for Forecasting – Data Warehouse, Data Cleaning and Imputation, Data Consideration and Model Selection, Qualitative and Quantitative Methods for Forecasting, Time Series Data – Characteristics and Components. **Unit II:** **Statistics Background for Forecasting** Graphical Displays – Plotting Smoothed Data, Numerical Descriptions of Data – Stationary, Autocovariance, Autocorrelation and Variogram, Data Transformation and Adjustments – Trends and Seasonal Adjustment. **Unit III:** **Forecasting Techniques** Extrapolation – Moving Averages and Exponential Smoothing, Introduction to Forecasting with Regression Models, Explanatory Models -	12 hours 12 hours 12 hours

	Forecasting with Multiple Regression, Time Series Decomposition, ARIMA (Box–Jenkins) Forecasting Model, Applications in Business. **Unit IV:** **Predictive Analytics and Forecasting** Helping to make sense of Big Data, Big Data in Forecasting, Artificial Intelligence in Forecasting, Classification Models – The most used Models in Analytics, Forecast/Analytics Implementation for Decision Making, Communicating Forecasting and Analytics to Stakeholders.	12 hours
Pedagogy:	Lectures/ tutorials/laboratory work/ field work/ outreach activities/ project work/ vocational training/viva/ seminars/ term papers/assignments/ presentations/ self-study/ Case Studies etc. or a combination of some of these. Sessions shall be interactive in nature to enable peer group learning.	
References/ Readings:	1. By Barry Keating; J. Holton Wilson; Shovan Chowdhury; Forecasting and Predictive Analytics, McGraw Hill, 2021 or Latest edition. 2. Peter J. Brockwell; Richard A. Davis; Introduction to Time Series and Forecasting, Springer, 2002 or Latest Edition. 3. Douglas C. Montgomery; Cheryl L. Jennings; Murat Kulahci; Introduction to Time Series and Forecasting, Wiley, 2015 or Latest Edition. 4. Michael Gilliland; Len Tashman; Udo Sglavo; Business Forecasting: The Emerging Role of Artificial Intelligence and Machine Learning, Wiley, 2021 or Latest Edition.	
Learning Outcomes:	At the end of the course, the participants will be able to: • Provide analytical solutions to business forecasting problems and turn business data into information for decision-making.	

(Back to Index) (Back to Agenda)

Programme: MSc (Decision Sciences)
Course Code: IMC-642
Title of Course: Human Resources Analytics
Number of Credits: 4 (4L-0T-0P)
Effective from AY: 2023-24

Prerequisite for the course	**Human Resource Management**	
Objective:	To equip participants with tools and frameworks available for Human Resources Analytics.	
Content:	**Unit I:** **Role of Analytics** HR Analytics: value creation, Diagnosing HR Challenges, Typical problems, Foundations of Data Science – Role of Artificial Intelligence (AI) and its various components such as Statistical Learning (SL), Machine Learning (ML) and Deep Learning Algorithms in Organisational Value Creation, Linking HR Data to Operational Performance. **Unit II:**	12 hours 12 hours

	HRA Frameworks Current Approaches to Measuring HR, Strategic HR Metrics versus Benchmarking, HR Maturity Framework: From level 1 to level 5, HR Analytics Frameworks: LAMP Framework, HCM: 21 Framework and Talentship Framework, Components **Unit III:** **Predictive Analytics** Predictive Analytics: Procedure, Determining Key Performance Indicators, Analysing and reporting data, Interpreting the Results and Predicting the Future, Metrics and Regression Analysis and Causation, Insights into Data Driven HRA: Sources, Issues, Building Support and Interest, Obtaining, Cleaning and Supplementing data, HR Metrics, HR Dashboards, Statistical Softwares, Data Visualisation Tools, Story Telling framework, Using Operations Research Tools in Talent Management. **Unit IV:** **Prescriptive Analytics** Prescriptive Analytics: Techniques - Linear Programming, Data Envelopment Analysis, Responding to HR Challenges through Prescriptive Analytics, Prescriptive Analytics as a Process to Influence Stakeholders, Contextualized Prescriptions, Optimization through Prescriptive Analytics.	12 hours 12 hours
Pedagogy:	Lectures/ tutorials/laboratory work/ field work/ outreach activities/ project work/ vocational training/viva/ seminars/ term papers/assignments/ presentations/ self-study/ Case Studies etc. or a combination of some of these. Sessions shall be interactive in nature to enable peer group learning.	
References/ Readings:	1. Jac Fitz- enz; John R. Mattox; Predictive analytics for Human Resources; Wiley; 2014 or Latest Edition. 2. Gene Pease Boyce Byerly; Jac Fitz-enz; Human Capital Analytics, Wiley; 2013 or Latest Edition. 3. Brian E. Becker; Mark A. Huselid; Mark A Huselid; David Ulrich; The HR Scorecard: Linking People, Strategy, and Performance; HBR Press; 2001 or Latest Edition. 4. Tracey Smith; HR Analytics: The What, Why and How; Numerical Insights LLC; 2017 or Latest Edition. 5. Dipak Kumar Bhattacharya; HR Analytics – Understanding theories and Applications, Sage, 2017 or Latest Edition.	
Learning Outcomes:	At the end of the course, the participants will be able to: • Use Tools and Frameworks available for HRA • Evaluate Various HRA frameworks • Design a system for using predictive/ prescriptive analytics	

(Back to Index) (Back to Agenda)

Programme: MSc (Decision Sciences)
Course Code: IMC-643
Title of Course: Financial Modeling
Number of Credits: 4 (4L-0T-0P)

Effective from AY: 2023-24

Prerequisites for the course:	**Financial Management**	
Objective:	To enable the participants to use Spreadsheets to make Financial Decisions by building models.	
Content:	**Unit I:** Overview of designing models using a spreadsheet – Attributes of the spreadsheet, Common faults, Design Process, Examining User needs and required user interface, Breaking down the calculations into manageable groups. **Unit II:** Poducing individual modules, Menu structure, Management reports and Summaries, Development, Auditing and sensitivity testing, Documentation. Features and Techniques. **Unit III:** Analysing performance (P&L Account, Balance Sheet, Key Ratios, Trend Analysis, Sustainability), Cash Flow (Deriving Cash Flow, Strained Cash Flow and Overtrading). **Unit IV:** Forecasting Models (Regression, Data Smoothening, Cyclicality and Seasonality), Variance Analysis (Budget Variances, Flash Reports and Graphics), Cost of Capital (CAPM, WACC, growth model), Bonds (Pricing, Yield Measurement, Convexity and Sensitivity and Portfolio Duration), Risk Analysis, Depreciation, Company Valuation, Optimisation, Decision Trees.	12 hours 12 hours 12 hours 12 hours
Pedagogy:	Lectures/Tutorials/Laboratory Work/ Field Work/ Outreach Activities/ Project Work/ Vocational Training/Viva/ Seminars/ Term Papers/Assignments/ Presentations/ Self-Study/ Case Studies Etc. or a Combination of Some of these. Sessions shall be Interactive in nature to enable Peer Group Learning.	
Learning Outcomes:	At the end of this course, the participants will be able to: • Design and build Financial Models using Spreadsheets to make business decisions.	
References/ Readings:	1. Shmuel Oluwa; Hands-On Financial Modelling with Microsoft Excel; Packt; 2019 or Latest Edition. 2. Daniel Stein Fairhurst; Using Excel for Business Analysis: A Guide to Financial Modelling Fundamentals; Weily; 2015 or Latest Edition. 3. Pandey I. M.; Financial Management; Pearson, India; 2022 or Latest Edition. 4. M Y Khan and P K Jain; Management Accounting, Text, Problems and Cases; McGraw Hill Education; 2018 or Latest Edition. 5. Alastair L. Day; Mastering Financial Modelling in Microsoft Excel; Pearson; 2012 or Latest Edition.	

(Back to Index) (Back to Agenda)

X AC- 14
13.10.2023

Programme: MSc (Decision Sciences)
Course Code: IMC-644
Title of Course: Marketing Research
Number of Credits: 4 (6L-0T-0P)
Effective from AY: 2023-24

Prerequisites for the course:	**Marketing Management**	
Objective:	To introduce the different research tools and techniques used in marketing decisions.	
Contents:	**Unit I:** **Research Design** Problem definition, theoretical framework, analytical model, research questions, hypotheses, information specification, ethics in marketing research, Research methods. **Unit II:** **Measurement and Scaling** Measurement and scaling, nominal, ordinal, interval and ratio scales, likert, semantic differential and stapel scales, reliability and validity, questionnaire design, question structure, question wording, order of questions, form design **Unit III:** **Data collection and Preliminary Analysis** Sampling, defining target population, non probability and probability sampling, sample size determination, data collection methods and field work, coding, data entry and data preparation, frequency distribution, cross tabulation and chi-square, analysis of variance **Unit IV:** **Multivariate Analysis** Correlation and regression analysis, simple and multiple regression, interpretation of results, discriminant analysis, factor analysis, extraction and rotation methods, logistic regression, cluster analysis, multi dimensional scaling, report preparation and presentation, usage of a statistical package like SPSS	12 hours 12 hours 12 hours 12 hours
Pedagogy:	Lectures/ tutorials/laboratory work/ field work/ outreach activities/ project work/ vocational training/viva/ seminars/ term papers/assignments/ presentations/ self-study/ Case Studies etc. or a combination of some of these. Sessions shall be interactive in nature to enable peer group learning.	
Learning Outcomes:	At the end of this course, the participants will be able to: • Design research projects that helps in marketing decisions.	

Prerequisites for the course:	**Marketing Management**	
References/ Readings:	1. Naresh K Malhotra; Marketing Research: An applied orientation, Latest Edition Pearson Education. 2. Joseph F Hair, Robert P Bush and David J Ortinau; Marketing Research within a changing information environment, Latest Edition, Tata McGraw Hill.	

(Back to Index) **(Back to Agenda)**

Annexure IV

MSc-Integrated Programme Project Assessment Details

Total Credits: 6 Total marks: 150

In-Semester Assessment (ISA): 90 marks (60% weightage) and

Semester End Assessment (SEA): 60 marks (40 % weightage)

The break-up for the In Semester Assessment is as follows -

1. Problem Definition, Literature survey- 20 marks
2. Data Collection and Analysis- 20 marks
3. Model selection – whether experiments were done to choose the right model and Performance study done - 20 marks
4. Maintenance of Project Work Diary – 10 marks
5. Whether Project objectives are met – 20 marks

The breakup of End semester Exam is as follows -

1. Presentation – 40 marks
2. Report - 20 marks

ISA as well as SEA component will be evaluated by the Internal Guide, External Guide (if any), 2 External Examiners – faculty members other than guides/mentor for Project.

Suggested Template for Project Report Submission

Title Page:
Certificate from Internal Guide:

Abstract
A summary of the project that mentions the broader scope of the project work and why it is important; the research question or technical problem addressed by the project; the main contributions (e.g., data gathering, developed methods and algorithms, experimental evaluation) and results.

Chapter 1: Introduction
The introduction should briefly give the motivation of undertaking the project. It should be written in a way that allows anyone to understand the importance of the work carried out by you, even if they are not experts in the topic.

Chapter 2: Literature Survey

Organize this chapter in sections, with one section for each research area that is related to your thesis. For each research area, cite all the publications that are related to your topic, and describe at least the most important of them.

Chapter 3: Terminology Used

In this chapter, place the information that is necessary for you to describe the contributions and results of the project. It will differ from project to project.

Chapter 4: Methodology Used

For a Computer Science thesis, this part typically describes the algorithm(s) developed for the thesis. For a Data Science thesis, this part typically describes the method for the analysis.

Chapter 5: Experimental Results

This chapter describes the results obtained when the methods of Chapter 4 are used on data. For a Computer Science thesis, this part typically describes the performance of the developed algorithm(s) on various synthetic and real datasets. For a Data Science thesis, this part typically describes the findings of the analysis. The chapter should also describe what insights are obtained from the results.

Chapter 6: Conclusion and Future Work

Summarize the contribution of the project. Provide an evaluation: are the results conclusive; are there limitations in the contribution? How would you extend the project work objective, what can be done next on the same topic?

References

(Back to Index) **(Back to Agenda)**