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Semester-VII

COURSE CODE	CATEGORY	COURSE NAME	TEACHING&EVALUATION SCHEME								
			THEORY			PRACTICAL		L	T	P	CREDITS
			ENDSEM University Exam	Two Term Exam	Teachers Assessment*	ENDSEM University Exam	Teachers Assessment*				
BTCSCS401	**DCC**	**Usability Design of Software Applications**	**60**	**20**	**20**	**30**	**20**	**2**	**0**	**2**	**3**

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;
***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

Course Objectives:

1. To sensitize the students to the fundamentals of User Centered Design.
2. To learn the knowledge of heuristic evaluation.
3. To learn User Experiences and their relevance and contribution to businesses
4. To Familiarize them to the facets of User Experience (UX) Design, particularly as applied to the digital artifacts
5. To understand the development of prototypes for their project.

Course Outcomes: The major emphasis of the course will be on creating a learning system through which management students can enhance their innovation and creative thinking skills, acquaint themselves with the special challenges of starting new ventures and use IPR as an effective tool to protect their innovations and intangible assets from exploitation.

1. To sensitize the students to the fundamentals of User Centered Design and User Experience their relevance and contribution to businesses
2. Familiarize them to the facets of User Experience (UX) Design, particularly as applied to the digital artefacts
3. Appreciation of user research, solution conceptualization and validation as interwoven activities in the design and development lifecycle
4. Acquire the ability to constructively engage with the Design professionals they would work with in the future-

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Syllabus:

Unit I

Introduction to User Centred Design,Aspects of User Centred Design Product Appreciation Assignment – Evaluating the product from user centred design aspects such as functionality, ease of use, ergonomics, aesthetics.

Unit II

Heuristic Evaluation: 10 Heuristic Principles, Examples, Heuristic Evaluation: Group Assignment initiation (Website and App), Evaluation for key tasks of the app or website for heuristic principles, severity, recommendations.

Group Assignment Presentations and reviews. Group Project identification, Students will identify a project such as a website or mobile app to redesign. They will take this redesign

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Project through the design lifecycle:
Discovery
Define
Design
Implement (Design Prototype)
Usability Testing
The below design methods and techiques will be imparted w.r.t. the group project selected by the students.

UNIT III

UX Research: Understanding users, their goals, context of use, and environment of use.
Research Techniques: Contextual Enquiry, User Interviews, Competitive Analysis for UX Scenarios and Persona Technique, Presentation of Personas for the group project

UNIT IV

Design Thinking Technique**,** Discovery and brainstorming**,** Concept Development Task flow detailing for the Project

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UNIT V

Project Prototyping Iteration 1, Project Prototyping Iteration 2, Review and feedback
Final presentation of solution – Exam.

Text Books:

1. Class Handouts
2. Online forum links, reference articles, blogs
3. Interaction Design: Beyond Human-Computer Interaction, 4th Edition, Jenny Preece, Helen Sharp and Yvonne Rogers
4. About Face, 4th Edition, Alan Cooper and Robert Reimann
5. Observing the User Experience, Second Edition: A Practitioner's Guide to User Research. Elizabeth Goodman, Mike Kuniavsky, Andrea Moed
6. The Elements of User Experience: User-Centered Design for the Web and Beyond. 2nd Edition, Jesse James Garrett.
7. Understanding Design Thinking, Lean, and Agile - Jonny Schneider

Reference Books:

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BTCSCS402	SEC	IT Workshop Scilab/ Matlab	60	20	20	30	20	2	0	2	3

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Course Objectives:

1. To Impart the Knowledge to the students with MATLAB software
2. 2. To provide a working introduction to the Matlab technical computing environment

Course Outcomes: Upon the completion of the course, students will be able to:

1. Understand and learn Matlab and its Workspace
2. Apply Mathematical functions of Matlab
3. Identify Plotting Functions
4. Understand Matlab Programming
5. Learn Debugging

Syllabus:

UNIT I

Introduction to MATLAB

History, basic features, strengths and weaknesses, good programming practices and plan your code

Working with variables, workspace and miscellaneous commands

Creating MATLAB variables, overwriting variable, error messages, making corrections, controlling the hierarchy of operations or precedence, controlling the appearance of floating point number, managing the workspace, keeping track of your work session, entering multiple statements per line, miscellaneous commands.

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UNIT II

Matrix, array and basic mathematical functions

Matrix generation, entering a vector, entering a matrix, matrix indexing, colon operator, linear spacing, creating a sub-matrix, dimension, matrix operations and functions matrix generators, special matrices, array and array operations, solving linear equations, other mathematical functions.

UNIT III

Basic plotting

Overview, creating simple plots, adding titles, axis labels, and annotations, multiple data sets in one plot, specifying line styles and colours

UNIT IV

Introduction to programming

Introduction, M-File Scripts, script side-effects, M-File functions, anatomy of a M-File function, input and output arguments, input to a script file, output commands

Control flow and operators

``if ... end" structure, relational and logical operators, ``for ... end" loop, ``while ... end" loop, other flow structures, operator precedence, saving output to a file

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UNIT V

Debugging M-files

Debugging process, preparing for debugging, setting breakpoints, running with breakpoints, examining values, correcting and ending debugging, correcting an M-file

List of Practical's:

Implementation of various Image Processing Algorithms

Text Books:

1. Digital Image Processing using MATLAB. Rafael C. Gonzalez, Richard E. Woods, Steven Eddins, Pearson Education, Inc., 2004.
2. MATLAB: A Practical Introduction to Programming and Problem Solving. Stormy Attaway, Butterworth-Heinemann.

Reference Books:

3. https://www.mathworks.com/content/dam/mathworks/mathworks-dot-com/moler/exm/book.pdf
4. https://www.mathworks.com/help/releases/R2014b/pdf_doc/matlab/getstart.pdf

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BTCSCS405	DCC	Services Science & Service Ops Management	60	20	20	30	20	3	0	4	5

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Course Objectives:

1. To provide an in-depth appreciation and understanding of the unique challenges inherent in managing and delivering services.

Course Outcomes: Upon the completion of the course, students will be able to:

1. Understand concepts about Services and distinguish it from Goods
2. Able to identify characteristics and nature of Services
3. Comprehend ways to design Services and evaluate them using Service qualities
4. Understand how various methods can be used to operate and manage Service businesses
5. Understand how innovation can be approached from Services point of view

Syllabus:

UNIT I

Introduction: Introduction to the course, Introduction to service operations, Role of service in economy and society, Introduction to Indian service sector

Nature of Services and Service Encounters: Differences between services and operations, Service package, characteristics, various frameworks to design service operation system, Kind of service encounter, importance of encounters

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Service-Dominant Logic: From Goods-Dominant logic to Service-Dominant logic, Value Co-creation

UNIT II

Service Strategy and Competitiveness: Development of Strategic Service Vision (SSV), Data Envelopment Analysis

New Service Development: NSD cycle, Service Blueprinting, Elements of service delivery system

Service Design: Customer Journey and Service Design, Design Thinking methods to aid Service Design

Locating facilities and designing their layout: models of facility locations (Huff's retail model), Role of service-scape in layout design

Service Quality: SERVQUAL, Walk through Audit, Dimensions of Service quality & other quality tools

UNIT III

Service Guarantee & Service Recovery: How to provide Service guarantee? How to recover from Service failure?

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UNIT IV

Forecasting Demand for Services: A review of different types of forecasting methods for demand forecasting.

Managing Capacity and Demand: Strategies for matching capacity and demand,Psychology of waiting, Application of various tools used in managing waiting line in services.

Managing Facilitating Goods: Review of inventory models, Role of inventory in services

Managing service supply relationship: Understanding the supply chain/hub of service, Strategies for managing suppliers of service

Vehicle Routing Problem: Managing after sales service, Understanding services that involve transportation of people and vehicle, Techniques for optimizing vehicle routes

UNIT V

Service Innovation: Services Productivity, Need for Services Innovation

Student Project:

Option 1: Choose any service organization around and present it from the perspective of: nature of service, classification of service, blueprint or service design analysis, service quality, and any additional perspective you would like to add.

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Option 2: Choose any latest research paper in services and explain your understanding and feedback on the same.

Text Books:

1. Fitzsimmons & Fitzsimmons, Service Management: Operations, Strategy, Information Technology, McGraw Hill publications (7th edition)

Reference Books:

2. Wilson, A., Zeithaml, V. A., Bitner, M. J., & Gremler, D. D. (2012). Services marketing: Integrating customer focus across the firm. McGraw Hill.
3. Lovelock, C. (2011). Services Marketing, 7/e. Pearson Education India
4. Reason, Ben, and Lovlie, Lavrans, (2016) Service Design for Business: A Practical Guide to Optimizing the Customer Experience, Pan Macmillan India,
5. Chesbrough, H. (2010). Open services innovation: Rethinking your business to grow and compete in a new era. John Wiley & Sons.

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Reference Papers:

1. Karmarkar, U. (2004). Will you survive the services revolution? Harvard Business Review, 100-107.
2. Vargo, S. L., & Lusch, R. F. (2008). From goods to service (s): Divergences and convergences of logics. Industrial marketing management, 37(3), 254-259.
3. Vargo, S. L., & Lusch, R. F. (2008). "Service-Dominant Logic: Continuing the Evolution," Journal of the Academy of Marketing Science (36:1), pp. 1-10
4. Silvestro, R., Fitzgerald, L., Johnston, R., & Voss, C. (1992). Towards a classification of service processes. International journal of service industry management, 3(3), 62-75.
5. Vargo, S. L., Maglio, P. P., & Akaka, M. A. (2008). On value and value co-creation: A service systems and service logic perspective. European management journal, 26(3), 145-152.
6. Shostack, G.L., (1984), "Designing Services That Deliver," Harvard Business Review, January-February 1984, pp. 132-139
7. Evenson, S., & Dubberly, H. (2010). Designing for service: Creating an experience advantage. Introduction to service engineering, 403-413.
8. Edvardsson, B., & Olsson, J. (1996). Key concepts for new service development. Service Industries Journal, 16(2), 140-164.

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9. Goldstein, S. M., Johnston, R., Duffy, J., & Rao, J. (2002). The service concept: the missing link in service design research? Journal of Operations management, 20(2), 121-134.
10. Kumar, A., Zope, N. R., & Lokku, D. S. (2014, April). An approach for services design by understanding value requirements, identifying value carriers, developing value proposition, and subsequently realizing value. In Global Conference (SRII), 2014 Annual SRII (pp. 298-304). IEEE.
11. Parasuraman, A., Zeithaml, V.A., and Berry, L.L., (1985), "A Conceptual Model of Service Quality and Its Implications for Future Research," The Journal of marketing, Vol. 49, No. 4, pp. 41-50
12. Cronin, J.J., and Taylor, S.A., (1992), "Measuring Service Quality: A Reexamination and Extension," The Journal of Marketing, Vol. 56, No. 3, pp. 55-68
13. Van Ree, H. J., (2009), Service Quality Indicators for Business Support Services, Ph.D. Thesis, University College London, London.
14. Zope, N. R., Anand, K., & Lokku, D. S. (2014, April). Reviewing Service Quality for IT Services Offerings: Observations in the Light of Service Quality Models & Determinants. In Global Conference (SRII), 2014 Annual SRII (pp. 43-49). IEEE.

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15. Heskett, J.L., Jones, T.O., Loveman, G.W., Sasser, W.E., and Schlesinger, L.A., (2008), "Putting the Service-Profit Chain to Work," Best of HBR, Harvard Business Review, July-August 2008, pp. 118-128
16. Clatworthy, S. (2011). Service innovation through touch-points: Development of an innovation toolkit for the first stages of new service development. International Journal of Design, 5(2).
17. Barras, R. (1986). "Towards a Theory of Innovation in Services," Research Policy (15), pp. 161-173.
18. Gustafsson, A., and Johnson, M. (2003). Competing in a Service Economy: How to Create a Competitive Advantage Through Service Development and Innovation, San Francisco: Jossey-Bass.
19. Barrett, M., Davidson, E., Prabhu, J., & Vargo, S. L. (2015). "Service innovation in the digital age: key contributions and future directions". Mis Quarterly, 39(1), 135-154.
20. Lusch, R. F., and Nambisan, S. (2015). "Service Innovation; A Service-Dominant Logic Perspective," MIS Quarterly (39:1), pp.155-175

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BTCSCS406	**DCC**	**IT Project Management**	**60**	**20**	**20**	**30**	**20**	**3**	**0**	**2**	**4**

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Course Objectives:

1. To understand the project scheduling techniques
2. 2. To study agile project management techniques

Course Outcomes: Upon the completion of the course, students will be able to:

1. To effectively plan, manage, execute, and control projects within time and cost targets with a focus on Information Technology and Service Sector.
2. Students will also learn agile project management techniques such as Scrum and DevOps.

Syllabus:

UNIT I

Project Overview and Feasibility Studies- Identification, Market and Demand Analysis, Project Cost Estimate, Financial Appraisal

Project Scheduling: Project Scheduling, Introduction to PERT and CPM, Critical Path Calculation, Precedence Relationship, Difference between PERT and CPM, Float Calculation and its importance, Cost reduction by Crashing of activity.

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UNIT II

Cost Control and Scheduling: Project Cost Control (PERT/Cost), Resource Scheduling & Resource Leveling

Project Management Features: Risk Analysis, Project Control, Project Audit and Project Termination

UNIT III

Agile Project Management: Introduction, Agile Principles, Agile methodologies, Relationship between Agile Scrum, Lean, DevOps and IT Service Management (ITIL).

Scrum: Various terminologies used in Scrum (Sprint, product backlog, sprint backlog, sprint review, retro perspective), various roles (Roles in Scrum), Best practices of Scrum.

UNIT IV

DevOps: Overview and its Components, Containerization Using Docker, Managing Source Code and Automating Builds, Automated Testing and Test Driven Development,Continuous Integration, Configuration Management, Continuous Deployment, Automated Monitoring.

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BTCSCS406	**DCC**	**IT Project Management**	**60**	**20**	**20**	**30**	**20**	**3**	**0**	**2**	**4**

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UNIT V

Other Agile Methodologies: Introduction to XP, FDD, DSDM, Crystal

Workshop:

Workshops will be conducted as a part of this course which is mandatory for students to attend. The primary objective of the workshops is to teach the students the agile project management including Scrum and DevOps through group activities.

Home Assignment:

Case studies will be distributed to students beforehand and students should prepare and try to solve these cases before coming to class. Students will be asked submit and present their understanding of the cases and solutions before the class.

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BTCSCS406	DCC	IT Project Management	60	20	20	30	20	3	0	2	4

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;
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Text Books:

1. Mike Cohn, Succeeding with Agile: Software Development Using Scrum
2. Notes to be distributed by the course instructor on various topics

Reference Books:

1. Roman Pichler, Agile Product Management with Scrum
2. Ken Schwaber, Agile Project Management with Scrum (Microsoft Professional)

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BTCSCS207	DCC	Human Resource Management	60	20	20	-	-	3	0	0	3

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;
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Course Objectives:

1. To provide students the insights of human resource management concepts, challenges, and practices.

Course Outcomes: Upon the completion of the course, students will be able to:

1. Students must be aware of the basic principles of Human Resource Management because success in today's complex business environment depends on effective management of its human resources.
2. This introductory course on Human Resource Management will familiarize the students with the basic concepts, roles, functional areas and activities of HR and help students understand organization's employees, their interest, motivation and satisfaction, and their belief of fair treatment- all of which actually impact the firm's current performance and sustainability in the long run

Syllabus:

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UNIT I

Human Resource Management: Concept and Challenges, HR Philosophy, Policies, Procedures and Practices.

UNIT II

Human Resource System Design: HR Profession, and HR Department, Line Management Responsibility in HRM, Measuring HR, Human resources accounting and audit; Human resource information system

UNIT III

Functional Areas of HRM: recruitment and staffing, benefits, compensation, employee relations, HR compliance, organizational design, training and development, human resource information systems (H.R.I.S.) and payroll.

UNIT IV

Human Resource Planning: Demand Forecasting, Action Plans– Retention, Training, Redeployment & Staffing, Succession Planning

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UNIT V

Strategic Management of Human Resources: SHRM, relationship between HR strategy and overall corporate strategy, HR as a Factor of Competitive Advantage, Managing Diversity in the Workplace

Human Resource Management in Service Sector- Special considerations for Service Sector including

- Managing the Customer – Employee Interaction
- Employee Empowerment and Customer Satisfaction
- Service Failure and Customer Recovery – the Role of Communication and Training
- Similarities and Differences in Nature of Work for the Frontline Workers and the Backend
- Support Services - Impact on HR Practices Stressing Mainly on Performance
- Flexible Working Practices – Implications for HR

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Home Assignment:

Further, the topic for class discussion will be mentioned beforehand. Students are required to meet in groups before coming to class and prepare for the topic to be discussed. Instructor may ask the student groups to present their analysis and findings to the class. Few topics are mentioned below as examples. Instructor can add or change any topic as per requirement.

1. Topic: Understanding the issues and challenges involved in managing a diverse workforce
2. Topic: Is The Only Purpose of a Corporation to Maximize Profit?
3. Topic: Similarities and Differences in Manufacturing and Service Sector - Impact on HR Practices

Text Books:

1. Gary Dessler, Human Resource Management

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BTCSDS4031	DSE	Cognitive Science & Analytics	60	20	20	30	20	2	1	2	4

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;
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Syllabus:

UNIT I

FOUNDATIONAL AREAS OF ANALYTICS

Introduction to Analytics: Definition, Description & Evolution of Analytics, History of Analytics, and Applicability of Analytics with development of Technology and Computer, How Analytics entered mainstream

Concepts of Analytics: Various overlapping concepts and fields of Analytics such as Data Mining, Machine Learning, Artificial Intelligence and Simulation

Emerging Areas in Analytics: Understanding of emerging research areas of Analytics: Mathematical programming, Evolutionary computation, Simulation, Machine learning/data mining, Logic-based models, and, Combinations of categories

Value Chain of Analytics: Descriptive Analytics Covering Exploratory Data Analysis & Basic of Statistics, Diagnostics Analytics: BI/Analysis, Trend, Pattern, Simultaneous Relationship, Predictive Analytics: Cause-Effect Relationship and Futuristic prediction in terms of probabilities, Continuous & Categorical Predictions, Simulation, Optimization, Multi-faceted Intelligent Technology driven Analytics combining Machine Intelligence with Human Brain Processing Abilities

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UNIT II: FOUNDATIONAL AREAS OF COGNITIVE SCIENCE

Introduction & Evolution of Cognitive Science: Introduction to the study of cognitive sciences, Brief history of cognitive science development and Methodological concerns in philosophy

Understand Brain and Sensory Motor Information: Fundamentals of Neuro Science, Processing of sensory information in the brain, and Brain Imaging Elements

Language & Linguistic Knowledge: Background and details of Syntax & Semantics, Understanding of Generative Linguistic

Memory & Processing: Theory of Information Processing, Fundamentals of Short term Memory

UNIT III: DATA THEORY & TAXONOMY OF DATA

Data as a whole: Understanding of Data as a whole for distinguishing and relating various types of data and Categorization of Data: Structured, Unstructured Data, Quantitative & Qualitative Data.

Views of Data: Understanding Data as an interdisciplinary framework for learning methodologies: covering statistics, neural networks, and fuzzy logic

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Measurement & Scaling Concepts: Measurement of variables and commonly used statistical tools: Number of procedures for measurement of the variables,

Categorization procedures, Scale construction procedures and Techniques of data processing for qualitative as well as quantitative data;

Various types of Scales: Nominal, Ordinal, Interval & Ratio Scales

UNIT IV: MULTIVARIATE DATA ANALYTICS & COGNITIVE ANALYTICS

Overview: High level overview of Categorization of Techniques: Inter-dependence Relationship Techniques and Dependence Relationship Techniques

Overview of Commonly Used Inter-dependence Techniques: Factor Analysis, Principal Component Analysis (PCA), Cluster Analysis

Overview of Commonly Used Dependence Techniques: Regression, Logistic Regression

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Analytics Value Chain &Application of Analytics across Value Chain:

a. Basic statistical concepts such as Descriptive & Diagnostics statistics, concept of random variables, discrete and continuous random variables, confidence interval, hypothesis testing, analysis of variance and correlation.

b. Predictive analytics techniques such as multiple linear regression, logistic regression, decision tree learning Clustering and forecasting techniques.

c. Prescriptive analytics Concepts: linear programming, integer programming, goal programming & stochastic models

d. Cognitive analytics Concepts: Text Analytics, Learning Analytics, Data Mining, Cognitive Systems, Cognitive Computing, Learning Data Science, Machine Learning, Big data Analytics and Business analytics

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UNIT 5: ARTIFICIAL INTELLIGENCE & MACHINE LEARNING

Fundamentals of Artificial Intelligence: Various areas of AI:

a. Knowledge: Text Analytics, Topic Modelling, Natural Language Processing (NLP), Natural Language Generation (NLG), Natural Language Understanding (NLU), Named-entity recognition (NER)
b. Perception: Image Analytics, Video Analytics & Audio Analytics
c. Memory: Cognitive Engagement: BOTs, Virtual & Digital Assistants, Augmented Reality, Virtual Reality, Mixed Reality
d. Learning: Intelligent Automation

Spectrum of AI

a. Reactive Machine: Low memory, works on Known rules, such as Object Detection/Games/Recommendations specific to known Rules
b. Limited Memory: Memory used to learn and improve continuously such as Most ML Models, Automated Vehicles
c. Theory of Mind: Machine Understands and responds such as BoTs/Virtual/Digital Assistants
d. Self-Aware: Human like intelligence such as Super Robots in Space etc.

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UNIT 6: APPROACH & METHODOLOGY

World Standard Methodology: CRISP-DM Methodology, SEMMA Methodology

Real Life Work around Multi-Variate Analytics: A few Selected Commonly used Techniques: Predictive & Classification Models, Regression, Clustering

Real Life Work around Artificial Intelligence, Machine Learning and Deep Learning: A few Selected Commonly used Techniques & Algorithms: ANN (Artificial Neural Network), CNN (Convolutional Neural Network), RNN (Recurrent Neural Network);

RN Architecture: LSTM, Bidirectional LSTM, Gated Recurrent Unit (GRU), CTRNN (Continuous Time RNN) CNN Architectures: VGG16, Alexnet, InceptionNet, RestNet, Googlenet

Object Detection models: R-CNN, Fast R-CNN, Faster R-CNN, cascade R-CNN. Mask RCNN, Single Shot MultiBox Detector (SSD) ,You Only Look Once (YOLO), Single-Shot Refinement Neural Network for Object Detection (RefineDet), Retina-Net

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Autoencoders: Denoising Autoencoder, GAN

Transformers: Attention based Encoder and Decoder: Eg- BERT(Bidirectional Encoder Representations from Transformers), Generative Pretrained Transformers GPT-3, GPT-2, BERT, XLNet, and RoBERTa

LAB EXERCISES

Structured Data Analytics: Segmentation & Clustering, Classification & Prediction, Forecasting Association Mining & Sequence Mining

Textual Data Analytics: Natural Language Processing (NLP), Natural Language Generation (NLG), Natural Language Understanding (NLU), Named-entity recognition (NER) driven Analytics: Key Word Extraction, Text Summarization, Insight Generation

Image Analytics: Malaria/Carcinoma/COVID detection, Visual inspection for QA/QC

Video Analytics: Motion based Behavior Recognition, Behavioural Observations, and Parkinson's Disease Prediction

Audio Analytics: Speech to Text, Text to Speech, Transcript Services

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Artificial Intelligence, Machine Learning driven Automation: Banking Process Automation, Hospital Triage Process Automation AR/VR enabled Guided Operations

Conversational Analytics: Artificial Intelligence, Machine Learning, Augmented Reality, Virtual Reality, Robotics, Digital/Virtual Assistant, Chat-BOT/ Program BOT, Email-BOT

Text Books

Unit I

1. Hall, P., Phan, W., & Whitson, K. (2016). Evolution of Analytics. O'Reilly Media Incorporated.

Unit II

1. Cognitive Science: An Introduction to the Science of the Mind by José Luis Bermúdez
2. Cognitive Computing and Big Data Analytics by Judith S. Hurwitz (Author), Marcia Kaufman (Author), Adrian Bowles (Author)
3. Cognitive Science and Artificial Intelligence Advances and Applications: Authors: Gurumoorthy, Sasikumar, Rao, B Narendrakumar, Gao, Xiao-Zhi

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Unit III

1. Cherkassky, V., & Mulier, F. M. (2007). Learning from data: concepts, theory, and methods. John Wiley & Sons.
2. The visual display of Quantitative Information: Edward Tufte, Graphics Press, 2001.
3. Scaling Measurement and Statistical Tools for Extension Workers by Krunal D. Gulkari, Hemant V. Borate , Mayur S. Shitap , 2016.

Unit IV

1. Hair, J. F., Anderson, R. E., Tatham, R. L., & Black, W. C. (1998). Multivariate data analysis. Englewood Cliff. New Jersey, USA, 5(3), 207-2019.
2. Kumar, U. D. (2017). Business analytics: The science of data-driven decision making. Wiley.
3. Özköse, H., Arı, E. S., & Gencer, C. (2015). Yesterday, today and tomorrow of big data. Procedia-Social and Behavioral Sciences, 195, 1042-1050.
4. Gudivada, Venkat N., M. T. Irfan, E. Fathi, and D. L. Rao. "Cognitive analytics: Going beyond big data analytics and machine learning." In Handbook of statistics, vol. 35, pp. 169-205. Elsevier, 2016.

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Unit V

1. Kao, A., & Poteet, S. R. (Eds.). (2007). Natural language processing and text mining. Springer Science & Business Media.
2. Demystifying Artificial intelligence: Simplified AI and Machine Learning concepts for Everyone (English Edition) Paperback – Import, 5 January 2021by Prashant Kikani
3. Kelleher, J. D., Mac Namee, B., & D'arcy, A. (2020). Fundamentals of machine learning for predictive data analytics: algorithms, worked examples, and case studies. MIT press.
4. Goodfellow, Ian, Yoshua Bengio, Aaron Courville, and Yoshua Bengio. Deep learning. Vol. 1, no. 2. Cambridge: MIT press, 2016.
5. Practical Deep Learning for Cloud, Mobile, and Edge: Real-World AI & Computer-Vision Projects Using Python, Keras & TensorFlow 1st Edition,
6. Conversational Chatbots for Analytics Third Edition by Gerardus Blokdyk
7. BORNET, P. B. (2020). Intelligent automation: Welcome to the world of hyperautomation. World Scientific Publishing Company.

Unit VI

1. Maimon, O., & Rokach, L. (Eds.). (2005). Data mining and knowledge discovery handbook.
2. Hair, J. F., Anderson, R. E., Tatham, R. L., & Black, W. C. (1998). Multivariate data analysis. Englewood Cliff. New Jersey, USA, 5(3), 207-2019.

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3. Zhang, C., & Ma, Y. (Eds.). (2012). Ensemble machine learning: methods and applications. Springer Science & Business Media.

Reference Books

Unit 1

1. Seminal Paper: The evolution of analytics and implications for industry and academic programs MR Bowers, JD Camm, G Chakraborty - Interfaces, 2018 - pubsonline.informs.org.

Unit 2

2. Cognitive Analytics: Concepts, Methodologies, Tools, and Applications (4 Volumes) Information Resources Management Association (USA)A first course in Probability, S. M. Ross, Prentice Hall.

Unit 3

1. Seminal paper: Shneiderman, B. (2003). The eyes have it: A task by data type taxonomy for information visualizations. In The craft of information visualization (pp. 364-371). Morgan Kaufmann.C: The Complete Reference, (Fourth Edition), Herbert Schildt, McGraw Hill.

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SECTION – IV: PEDAGOGY

Unit I

1. Instructor Led
2. Mini Assignments & Quiz.

Unit II

1. Instructor Led
2. Mini Assignments & Quiz.

Unit III

1. Instructor Led
2. Mini Assignments & Quiz.

Unit IV

1. Instructor Led
2. Mini Assignments & Quiz
3. Industry Speakers

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COURSE CODE	CATEGORY	COURSE NAME	TEACHING&EVALUATION SCHEME								
			THEORY			PRACTICAL		L	T	P	CREDITS
			ENDSEM University Exam	Two Term Exam	Teachers Assessment*	ENDSEM University Exam	Teachers Assessment*				
BTCSDS4031	**DSE**	**Cognitive Science & Analytics**	**60**	**20**	**20**	**30**	**20**	**2**	**1**	**2**	**4**

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;
***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks

Unit V

1. Instructor Led
2. Mini Assignments & Quiz
3. Industry Speakers

Unit VI

1. Industry Speakers
2. Mini Assignments & Quiz

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COURSE CODE	CATEGORY	COURSE NAME	TEACHING&EVALUATION SCHEME								
			THEORY			PRACTICAL		L	T	P	CREDITS
			ENDSEM University Exam	Two Term Exam	Teachers Assessment*	ENDSEM University Exam	Teachers Assessment*				
BTCSDS4032	**DSE**	**Introduction to IoT**	**60**	**20**	**20**	**30**	**20**	**2**	**1**	**2**	**4**

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;
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Course Outcomes: Upon the completion of the course, students will be able to:

1. Basic principles and concepts of Internet-of-Things use cases, applications, architecture and technologies.
2. Students will get an overview of an end to end IoT system encompassing the edge, cloud and application tiers.
3. This course will build upon the foundations created in the pre-requisite courses and will equip the students to architect a complete IoT application on their own. The lab exercises will consist of hands-on experiments that will lead to building an IoT application end-to-end. Some of the specialized topics will be covered via student seminars where students are expected to research and present their findings in a seminar format.

Syllabus

UNIT I

Introduction to IoT and Use cases: Understanding basic concepts of IoT, Consumer IoT vs Industrial Internet, Fundamental building blocks, Use Cases of IoT in various industry domains,

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			THEORY			PRACTICAL		L	T	P	CREDITS
			ENDSEM University Exam	Two Term Exam	Teachers Assessment*	ENDSEM University Exam	Teachers Assessment*				
BTCSDS4032	**DSE**	**Introduction to IoT**	**60**	**20**	**20**	**30**	**20**	**2**	**1**	**2**	**4**

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;
***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks

UNIT II

Architecture: IoT reference architectures, Industrial Internet Reference Architecture, Edge Computing, IoT Gateways, Data Ingestion and Data Processing Pipelines, Data Stream Processing

UNIT III

Sensors and Industrial Systems: Introduction to sensors and transducers, integrating sensors to sensor processing boards, introduction to industrial data acquisition systems, industrial control systems and their functions

UNIT IV

Networking and Communication for IoT: Recap of OSI 7 layer architecture and mapping to IoT architecture, Introduction to proximity networking technologies (ZigBee, Bluetooth, Serial Communication), Industrial network protocols (Modbus, CANbus), Communicating with cloud applications (web services, REST, TCP/IP and UDP/IP sockets, MQTT, WebSockets, protocols. Message encoding (JSON, Protocol Buffers)

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			ENDSEM University Exam	Two Term Exam	Teachers Assessment*	ENDSEM University Exam	Teachers Assessment*				
BTCSDS4032	**DSE**	**Introduction to IoT**	**60**	**20**	**20**	**30**	**20**	**2**	**1**	**2**	**4**

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;
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UNIT V

IoT Data Processing and Storage: Time Series Data and their characteristics, time series databases, basic time series analytics, data summarization and sketching, dealing with noisy and missing data, anomaly and outlier detection,

IoT Seminars:

Selected topics in IoT should be handled via student seminars. Recommended that students form a group do research on at least one of the following topics and present it through seminars. They are expected to do a literature survey of the topic and present their survey paper to the class. The suggested topics are –

a) IoT Applications

- Smart Cities
- Connected Vehicles and Telematics
- Smart Grids
- Smart Homes

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BTCSDS4032	**DSE**	**Introduction to IoT**	**60**	**20**	**20**	**30**	**20**	**2**	**1**	**2**	**4**

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;
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b) IoT data visualization
c) Survey of cloud based IoT platforms
d) Low power wide area networks for IoT
e) IoT device management
f) Survey of chips, embedded modules and development boards for IoT devices
g) Embedded and real-time operating systems for IoT
h) IoT Security
   - Security risks in IoT
   - Securing IoT endpoint devices and secure communication protocols for IoT
   - Security and Privacy of IoT data

Lab Exercises

1. Setting up the Arduino Development Environment, connecting analog sensors to an Arduino Boarding and reading analog sensor data
2. Digital Input and Output reading using and Arduino board and Arduino Development Environment
3. Integrate an Arduino Board to a Raspberry Pi computer and send sensor data from Arduino to the R Pi
4. Setup Python on the R Pi and run sample R Pi programs on the R Pi. Read the data from Arduino using Python language

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BTCSDS4032	**DSE**	**Introduction to IoT**	**60**	**20**	**20**	**30**	**20**	**2**	**1**	**2**	**4**

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5. Connect a R Pi Camera module to the Raspberry Pi and using Python programming capture still images and video
6. Set up TCP/IP socket server on a PC. Send a message from the R Pi to the PC using socket communication
7. Set up a MQTT broker on the PC. Send data from R Pi to PC using MQTT protocol. Receive data from PC to R Pi using MQTT protocol
8. Connect LED lights to an Arduino. Connect the Arduino to the R Pi. Send Message from PC to R Pi via MQTT protocol. On receipt of the message , toggle the LED lights on the Arduino
9. Set up an account in a cloud service (such as Google / AWS or Azure). Set up a simple Http server using a language of your choice. Push the image captured from the R Pi camera to this web service. On receiving the image, store the image in a database or file
10. Develop a mobile application to view the images captured by the R Pi camera

Text Books:

1. The Internet of Things, Samuel Greengard, MIT Press Essential Knowledge Series,

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BTCSDS4032	**DSE**	**Introduction to IoT**	**60**	**20**	**20**	**30**	**20**	**2**	**1**	**2**	**4**

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;
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Reference Books / Links:

1. Industrial Internet Reference Architecture - http://www.iiconsortium.org/IIRA.htm
2. World Economic Forum Report on Industrial Internet of Things - https://www.weforum.org/reports/industrial-internet-things
3. 50 Sensor Applications for a Smarter World - http://www.libelium.com/resources/top_50_iot_sensor_applications_ranking/
4. Visualizing Data-Exploring and Explaining Data with the Processing Environment, By Ben Fry, Publisher: O'Reilly Media
5. Raspberry Pi Computer Architecture Essentials, by Andrew K Dennis
6. Getting Started with Arduino, M. Banzi, O Reilly Media
7. GSMA IoT Security Guidelines & Assessment - https://www.gsma.com/iot/future-iot-networks/iot-security-guidelines/

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COURSE CODE	CATEGORY	COURSE NAME	TEACHING&EVALUATION SCHEME								
			THEORY			PRACTICAL		L	T	P	CREDITS
			ENDSEM University Exam	Two Term Exam	Teachers Assessment*	ENDSEM University Exam	Teachers Assessment*				
BTCSDS4033	**DSE**	**Cryptology**	**60**	**20**	**20**	**30**	**20**	**2**	**1**	**2**	**4**

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;
***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks

COURSE OBJECTIVES:

1. Learning the fundamental principles and theories underlying cryptographic algorithms including the mathematical foundations of cryptography.

COURSE OUTCOMES:

1. Understand various Cryptographic Techniques
2. Understand Symmetric Key Cryptosystems
3. Apply various public key cryptography techniques
4. Understand the various Security Applications
5. Define Post-Quantum Cryptography

Syllabus

Unit I

Introduction to Cryptography: Elementary number theory, Pseudo-random bit generation, Elementary cryptosystems.

Basic security services: confidentiality, integrity, availability, non-repudiation, privacy

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BTCSDS4033	DSE	Cryptology	60	20	20	30	20	2	1	2	4

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;
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Unit II

Symmetric key cryptosystems: Stream Cipher: Basic Ideas, Hardware and Software Implementations, Examples with some prominent ciphers: A5/1, Grain family, RC4, Salsa and ChaCha, HC128, SNOW family, ZUC; Block Ciphers: DES, AES, Modes of Operation; Hash Functions; Authentication

Unit III

Public Key Cryptosystems: RSA, ECC; Digital signatures

Unit IV

Security Applications (Selected Topics): Electronic commerce (anonymous cash, micro-payments), Key management, Zero-knowledge protocols, Cryptology in Contact Tracing Applications, Issues related to Quantum Cryptanalysis.

Unit V

Introductory topics in Post-Quantum Cryptography: Refer to https://csrc.nist.gov/projects/post-quantum-cryptography. May discuss any two ciphers from this list.

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			THEORY			PRACTICAL		L	T	P	CREDITS
			ENDSEM University Exam	Two Term Exam	Teachers Assessment*	ENDSEM University Exam	Teachers Assessment*				
BTCSDS4033	DSE	Cryptology	60	20	20	30	20	2	1	2	4

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;
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Text Books:

1. Theory and Practice. D. R. Stinson, CRC Press.
2. Handbook of Applied Cryptography. A. J. Menezes, P. C. van Oorschot, and S. A. Vanstone, CRC Press

Reference Books:

3. A course in number theory and cryptography. N. Koblitz:, GTM, Springer.
4. Cryptography and Network Security. W. Stallings, Prentice Hall.
5. Security Engineering, R. Anderson, Wiley
6. RC4 Stream Cipher and Its Variants. G. Paul and S. Maitra: CRC Press, Taylor
7. & Francis Group, A Chapman & Hall Book, 2012
8. Design & Cryptanalysis of ZUC - A Stream Cipher in Mobile Telephony. C. S. Mukherjee, D. Roy, S. Maitra, Springer 2020
9. Contact Tracing in Post-Covid World - A Cryptologic Approach. P. Chakraborty, S. Maitra, M. Nandi, S. Talnikar, Springer 2020
10. Presskil Lecture notes: Available online: http://www.theory.caltech.edu/~preskill/ph229/

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COURSE CODE	CATEGORY	COURSE NAME	TEACHING&EVALUATION SCHEME								
			THEORY			PRACTICAL		L	T	P	CREDITS
			ENDSEM University Exam	Two Term Exam	Teachers Assessment*	ENDSEM University Exam	Teachers Assessment*				
BTCSDS4041	**DSE**	**Quantum Computation & Quantum Information**	**60**	**20**	**20**	**30**	**20**	**3**	**1**	**2**	**5**

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;
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Introduction to Quantum Information: States, Operators, Measurements, Quantum Entanglement: Quantum Teleportation, Super-dense coding, CHSH Game, Quantum gates and circuits

Quantum Algorithms: Deutsch-Jozsa, Simon, Grover, Shor, Implication of Grover's and Simon's algorithms towards classical symmetric key cryptosystems, Implication of Shor's algorithm towards factorization and Discrete Logarithm based classical public key cryptosystems

Quantum True Random Number Generators (QTRNG): Detailed design and issues of quantumness, Commercial products and applications

Quantum key distribution (QKD): BB84, Ekert, Semi-Quantum QKD protocols and their variations, Issues of Device Independence, Commercial products

Introductory topics in Post-Quantum Cryptography: Refer to https://csrc.nist.gov/projects/post-quantum-cryptography. May discuss any two ciphers from this list.

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			THEORY			PRACTICAL		L	T	P	CREDITS
			ENDSEM University Exam	Two Term Exam	Teachers Assessment*	ENDSEM University Exam	Teachers Assessment*				
BTCSDS4041	**DSE**	**Quantum Computation & Quantum Information**	**60**	**20**	**20**	**30**	**20**	**3**	**1**	**2**	**5**

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;
*__Teacher Assessment__ shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks

Text Books:

1. Quantum Computation and Quantum Information. M. A. Nielsen and I. L. Chuang, Cambridge University Press
2. Presskil Lecture notes: Available online: http://www.theory.caltech.edu/~preskill/ph229/

Reference Books:

1. An Introduction to Quantum Computing. P. Kaye, R. Laflamme, and M. Mosca, Oxford University Press, New York
2. Quantum Computer Science. N. David Mermin:, Cambridge University Press
3. Quantum Cryptography. D. Unruh:, Available online: https://courses.cs.ut.ee/all/MTAT.07.024/2017_fall/uploads/
4. NIST Post Quantum Cryptography, Available online: https://csrc.nist.gov/projects/post-quantum-cryptography/round-2-submissions
5. Quantum Algorithms for Cryptographically Significant Boolean Functions - An IBMQ Experience. SAPV Tharrmashastha, D. Bera, A. Maitra and S. Maitra, Springer 2020.
6. Quantum Algorithm Zoo. https://quantumalgorithmzoo.org/
7. Handbook of Applied Cryptography. A. J. Menezes, P. C. van Oorschot, and S. A. Vanstone. CRC Press

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			ENDSEM University Exam	Two Term Exam	Teachers Assessment*	ENDSEM University Exam	Teachers Assessment*				
BTCSDS4042	**DSE**	**Advanced Social, Text and Media Analytics**	**60**	**20**	**20**	**30**	**20**	**3**	**1**	**2**	**5**

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;
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COURSE OBJECTIVES:

1. Student will learn the basics concept of Analytics over Social, Text and Media

COURSE OUTCOMES:

1. To be able to use various tools for Text Mining and carry out Pattern Discovery, Predictive Modeling
2. Explore the use of social network analysis to understand the growing connectivity and complexity in the world around us on different scales – ranging from small groups to the World Wide Web
3. Perform social network analysis to identify important social actors, subgroups (i.e., clusters), and network properties in social media sites such as Twitter, Facebook, and YouTube

Syllabus:

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BTCSDS4042	**DSE**	**Advanced Social, Text and Media Analytics**	**60**	**20**	**20**	**30**	**20**	**3**	**1**	**2**	**5**

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;
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UNIT I

Text Mining: Introduction, Core text mining operations, Preprocessing techniques, Categorization, Clustering, Information extraction, Probabilistic models for information extraction, Text mining applications

UNIT II

Text Mining Methods & Approaches: Content Analysis; Natural Language Processing; Clustering & Topic Detection; Simple Predictive Modeling; Sentiment Analysis; Sentiment Prediction

UNIT III

Web Analytics: Web analytics tools, Clickstream analysis, A/B testing, online surveys; Web search and retrieval, Search engine optimization, Web crawling and Indexing, Ranking algorithms, Web traffic models.

UNIT IV

Social Media Analytics-I: Social network and web data and methods.

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BTCSDS4042	**DSE**	**Advanced Social, Text and Media Analytics**	**60**	**20**	**20**	**30**	**20**	**3**	**1**	**2**	**5**

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UNIT V

Social Media Analytics-II: Graphs and Matrices. Basic measures for individuals and networks. Information visualization; Making connections: Link analysis. Random graphs and network evolution. Social contexts: Affiliation and identity; Social network analysis.

Home Assignments:

1. **Language Analysis:** Students are expected to analyze the language of a category of text (e.g., literary, academic, social media) of their selection. Based on the analysis, students are expected to provide a critical description of the texts involved and possibly distinguishing them from other texts and/or uncovering relationships or concepts communicated by the text authors.
2. Students are required Perform sentiment analysis using Twitter. Students will be required to use off the-shelf software and/or code of their own to detect sentiment/emotion in the data and write a description of the methods they use and the results.

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			ENDSEM University Exam	Two Term Exam	Teachers Assessment*	ENDSEM University Exam	Teachers Assessment*				
BTCSDS4042	**DSE**	**Advanced Social, Text and Media Analytics**	**60**	**20**	**20**	**30**	**20**	**3**	**1**	**2**	**5**

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;
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Text Books:

1. Ronen Feldman and James Sanger, "The Text Mining Handbook: Advanced Approaches in Analyzing Unstructured Data", Cambridge University Press, 2006.
2. Hansen, Derek, Ben Sheiderman, Marc Smith. 2011 Analyzing Social Media Networks with NodeXL: Insights from a Connected World, Morgan Kaufmann, 304
3. Avinash Kaushik. 2009. Web Analytics 2.0: The Art of Online Accountability.
4. Hanneman, Robert and Mark Riddle. 2005. Introduction to Social Network Method

Reference Books:

1. Wasserman, S. & Faust, K. (1994). Social network analysis: Methods and applications. New York: Cambridge University Press.
2. Monge, P. R. & Contractor, N. S. (2003). Theories of communication networks. New York: Oxford University Press. http://nosh.northwestern.edu/vita.html

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			ENDSEM University Exam	Two Term Exam	Teachers Assessment*	ENDSEM University Exam	Teachers Assessment*				
BTCSDS4043	**DSE**	**Mobile Computing**	**60**	**20**	**20**	**30**	**20**	**3**	**1**	**2**	**5**

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COURSE OBJECTIVES:

1. To make the student understand the concept of mobile computing paradigm, its novel applications and limitations.

COURSE OUTCOMES:

1. Upon the completion of the course, students will be able to:
2. Discuss the basic of wireless and mobile infrastructure.
3. Understand the concepts of Location and handoff management.
4. Define Wireless transmission fundamentals
5. To understand Mobile Ad-hoc Networks and Routing Protocols
6. State the Cognitive radio networks and D2D in 5G

Syllabus

Unit I

Introduction: Overview of wireless and mobile infrastructure; Preliminary concepts on cellular architecture; Design objectives and performance issues; Radio resource management and interface; Propagation and path loss models; Channel interference and frequency reuse; Cell splitting; Channel assignment strategies; Overview of generations:- 1G to 5G.

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COURSE CODE	CATEGORY	COURSE NAME	TEACHING&EVALUATION SCHEME								
			THEORY			PRACTICAL		L	T	P	CREDITS
			ENDSEM University Exam	Two Term Exam	Teachers Assessment*	ENDSEM University Exam	Teachers Assessment*				
BTCSDS4043	**DSE**	**Mobile Computing**	**60**	**20**	**20**	**30**	**20**	**3**	**1**	**2**	**5**

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;
***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks

UNIT II

Location and handoff management: Introduction to location management (HLR and VLR); Mobility models characterizing individual node movement (Random walk, Fluid flow, Markovian, Activity based); Mobility models characterizing the movement of groups of nodes (Reference point based group mobility model, Community based group mobility model); Static (Always vs. Never update, Reporting Cells, Location Areas) and Dynamic location management schemes (Time, Movement, Distance, Profile Based); Terminal Paging (Simultaneous paging, Sequential paging); Location management and Mobile IP; Overview of handoff process; Factors affecting handoffs and performance evaluation metrics; Handoff strategies; Different types of handoffs (soft, hard, horizontal, vertical).

UNIT III

Wireless transmission fundamentals: Introduction to narrow and wideband systems; Spread spectrum; Frequency hopping; Introduction to MIMO; MIMO Channel Capacity and diversity gain; Introduction to OFDM; MIMO-OFDM system; Multiple access control (FDMA, TDMA, CDMA, SDMA); Wireless local area network; Wireless personal area network (Bluetooth and zigbee).

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Semester-VII

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UNIT IV

Mobile Ad-hoc networks: Characteristics and applications; Coverage and connectivity problems; Routing in MANETs.

Wireless sensor networks: Concepts, basic architecture, design objectives and applications; Sensing and communication range; Coverage and connectivity; Sensor placement; Data relaying and aggregation; Energy consumption; Clustering of sensors; Energy efficient Routing (LEACH).

Unit V

Cognitive radio networks: Fixed and dynamic spectrum access; Direct and indirect spectrum sensing; Spectrum sharing; Interoperability and co-existence issues; Applications of cognitive radio networks.

D2D communications in 5G cellular networks: Introduction to D2D communications; High level requirements for 5G architecture; Introduction to the radio resource management, power control and mode selection problems; Millimeter wave communication in 5G.

Laboratory

Development and implementation of different network protocols using network simulators such as NS-3 and OMNET++.

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Text Books:

1. Mobile Communications. Jochen Schiller, Pearson Education.
2. Wireless Communications. Andrea Goldsmith, Cambridge University Press.

Reference Books:

1. Wireless Communications: Principles and Practice. Theodore Rappaport, Pearson Education.
2. Wireless Communications. Ezio Biglieri, MIMO, Cambridge University Press.
3. Handbook of Wireless Networking and Mobile Computing. Ivan Stojmenovic, Wiley.
4. Dynamic Location Management in Heterogeneous Cellular Networks. James Cowling,
5. MIT Thesis. http://people.csail.mit.edu/cowling/hons/jcowling-dynamic-Nov04.pdf
6. Location Management in Wireless Cellular Networks. Travis Keshav, https://www.cse.wustl.edu/~jain/cse574-06/ftp/cellular_location.pdf
7. Location Management in Wireless Data Networks. Fahd A. Batayneh, https://www.cse. wustl.edu/~jain/cse574-06/ftp/wireless_location.pdf
8. Principles of Mobile Communication. Gordon L. Stber, Springer.

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***Teacher Assessment** shall be based following components: Quiz/

9. Wireless Device-to- DeviceCommunications and Networks. Lingyang Song, Dusit Niyato, Zhu Han, and Ekram Hossain, Cambridge University Press.
10. Principles of Cognitive Radio. Ezio Biglieri, Andrea J. Goldsmith, Larry J. Greenstein, Narayan Mandayam and H. Vincent Poor, Cambridge University Press.
11. Wireless Sensor Networks: Architecturesand Protocols. Edgar H. Callaway, Jr. and Edgar H. Callaway, CRC Press.

A Discrete-Event Network Simulator. https://www.nsnam.org/docs/manual/html/index.html