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Experience certainty.

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Semester 7

TCS

Computer Science & Business Systems

Semester 7 Curriculum

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Usability Design of Software Applications + Lab

Course Pre Requisite(s):

Basic understanding of web and mobile app development

Course Outcome(s):

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.

To sensitise the students to the fundamentals of User Centred Design and User Experience their relevance and contribution to businesses
Familiarise them to the facets of User Experience (UX) Design, particularly as applied to the digital artefacts
Appreciation of user research, solution conceptualisation and validation as interwoven activities in the design and development lifecycle
Acquire the ability to constructively engage with the Design professionals they would work with in the future

Topics to Be Covered:

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.

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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 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.
UX Research Understanding users, their goals, context of use, environment of use. Research Techniques: Contextual Enquiry, User Interviews, Competitive Analysis for UX
Scenarios and Persona Technique
Presentation of Personas for the group project
Design Thinking Technique Discovery and brainstorming
Concept Development
Task flow detailing for the Project
Prototyping Techniques Paper, Electronic, Prototyping Tools
Project Prototyping Iteration 1
Project Prototyping Iteration 2
Review and feedback
Final presentation of solution – Exam

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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

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IT Workshop Skylab / Matlab (PCC-CS 302) + Lab

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,

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.

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

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

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

Laboratory

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.

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Reference Books:

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

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FINANCIAL MANAGEMENT

Course Outcome(s):

Students will be able to

- Understand the fundamental concepts of financial management
- Appreciate basic concepts such as time value of money, cost of capital, risk and return, working capital management, capital budgeting etc.
- Leverage the concept for deciding financial angle of IT projects

Topics to Be Covered:

UNIT - I

1. **Introduction :** Introduction to Financial Management - Goals of the firm - Financial Environments.

2. **Time Value of Money :** Simple and Compound Interest Rates, Amortization, Computing more that once a year, Annuity Factor.

UNIT - II

3. **Valuation of Securities :** Bond Valuation, Preferred Stock Valuation , Common Stock Valuation, Concept of Yield and YTM.

4**. Risk & Return:** Defining Risk and Return, Using Probability Distributions to Measure Risk, Attitudes Toward Risk, Risk and Return in a Portfolio Context, Diversification, The Capital Asset Pricing Model (CAPM)

UNIT - III

5. Operating & Financial Leverage: Operating Leverage, Financial Leverage, Total Leverage, Indifference Analysis in leverage study

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6. **Cost of Capital** : Concept , Computation of Specific Cost of Capital for Equity - Preference – Debt, Weighted Average Cost of Capital – Factors affecting Cost of Capital 4L

7. Capital Budgeting : The Capital Budgeting Concept & Process - An Overview, Generating Investment Project Proposals, Estimating Project, After Tax Incremental Operating Cash Flows, Capital Budgeting Techniques, Project Evaluation and Selection - Alternative Methods

UNIT – IV

8. **Working Capital Management:** Overview, Working Capital Issues, Financing Current Assets (Short Term and Long Term- Mix), Combining Liability Structures and Current Asset Decisions, Estimation of Working Capital.

9. **Cash Management:** Motives for Holding cash, Speeding Up Cash Receipts, Slowing Down Cash Payouts, Electronic Commerce, Outsourcing, Cash Balances to maintain, Factoring.

10. **Accounts Receivable Management:** Credit & Collection Policies, Analyzing the Credit Applicant, CreditReferences, Selecting optimum Credit period. 4L

Text Book

Chandra, Prasanna - Financial Management - Theory & Practice, Tata McGraw Hill.

References Books :

Srivastava, Misra: Financial Management, OUP

Van Horne and Wachowicz : Fundamentals of Financial Management, Prentice Hall/ Pearson Education.

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Human Resource Management

Course Outcome(s):

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. 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.

Topics to Be Covered:

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

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

UNIT – VI

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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

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:

Gary Dessler, *Human Resource Management*

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Cognitive Science & Analytics (Elective V)

SECTION – I: THEORY

UNIT 1: 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

UNIT 2: 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

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UNIT 3: 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

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 4: 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

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

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.

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

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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

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

SECTION – II: 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

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

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SECTION – III: TEXT BOOKS

Text Books

Unit 1

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

Unit 2

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*

Unit 3

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 4

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.

Unit 5

1. Kao, A., & Poteet, S. R. (Eds.). (2007). Natural language processing and text mining. Springer Science & Business Media.

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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 6:

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.

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 1

1. Instructor Led
2. Mini Assignments & Quiz.

Unit 2

1. Instructor Led
2. Mini Assignments & Quiz.

Unit 3

1. Instructor Led
2. Mini Assignments & Quiz.

Unit 4

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

Unit 5

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

Unit 6

1. Industry Speakers

2. Mini Assignments & Quiz

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Introduction to IoT + Lab (Elective V)

Course Outcome(s):

This course will help students understand basic principles and concepts of Internet-of-Things use cases, applications, architecture and technologies. Students will get an overview of an end to end IoT system encompassing the edge, cloud and application tiers. 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.

Topics to Be Covered:

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,

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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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

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
5. Connect a R Pi Camera module to the Raspberry Pi and using Python programming capture still images and video

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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,

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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Cryptology (Elective V)

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

Bas ic security services: confidentiality, integrity, availability, non-repudiation, privacy

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

Public Key Cryptosystems: RSA, ECC; Digital signatures

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

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

Text Books:

3. *Cryptography, Theory and Practice.* D. R. Stinson, CRC Press.
4. *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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Note: If any student also opts for Quantum Computation & Quantum Information course, in that case the ciphers discussed in this course must differ from the ciphers that will be discussed in Quantum Computation & Quantum Information course.

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Quantum Computation & Quantum Information (Elective VI)

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.

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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Note: If any student also opts for Cryptology course, in that case the ciphers discussed in this course must differ from the ciphers that will be discussed in Cryptology course.

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Advanced Social, Text and Media Analytics (Elective VI)

Course Outcome(s):

Students will be able to

- To be able to use various tools for Text Mining and carry out Pattern Discovery, Predictive Modeling
- 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
- 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

Topics to Be Covered:

UNIT – I

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

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

UNIT – II

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 – III

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

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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.

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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Mobile Computing (Elective VI)

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.

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).

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).

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).

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.

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Laboratory

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

Text Books:

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

Reference Books:

3. *Wireless Communications: Principles and Practice.* Theodore Rappaport, Pearson Education.
4. *Wireless Communications.* Ezio Biglieri, MIMO, Cambridge University Press.
5. *Handbook of Wireless Networking and Mobile Computing.* Ivan Stojmenovic, Wiley.
6. *Dynamic Location Management in Heterogeneous Cellular Networks.* James Cowling,
7. MIT Thesis. http://people.csail.mit.edu/cowling/hons/jcowling-dynamic-Nov04.pdf
8. *Location Management in Wireless Cellular Networks.* Travis Keshav, https://www.cse.wustl.edu/~jain/cse574-06/ftp/cellular_location.pdf
9. *Location Management in Wireless Data Networks.* Fahd A. Batayneh, https://www.cse. wustl.edu/~jain/cse574-06/ftp/wireless_location.pdf
10. *Principles of Mobile Communication.* Gordon L. Stber, Springer.
11. *Wireless Device-to- DeviceCommunications and Networks.* Lingyang Song, Dusit Niyato, Zhu Han, and Ekram Hossain, Cambridge University Press.
12. *Principles of Cognitive Radio.* Ezio Biglieri, Andrea J. Goldsmith, Larry J. Greenstein, Narayan Mandayam and H. Vincent Poor, Cambridge University Press.
13. *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