COMPUTER APPLICATIONS

Ph.D Course Work Syllabus

Subject Code	Subject Name	Core/ Optional	Credits	Marks	L	P
PCA-RS-C101	Research Methodology	C	4	100	3	1
PCA-RS-C102	Research Proposal Preparation	C	4	100	0	4
PCA-RS-E103	Remote Sensing	E	4	100	4	0
PCA-RS-E104	Geographic Information System	E	4	100	4	0
PCA-RS-E105	Digital Image Processing	E	4	100	4	0
PCA-RS-E106	Advanced Computer Networks	E	4	100	4	0
PCA-RS-E107	Wireless Sensor Networks	E	4	100	4	0
PCA-RS-E108	Data Analytics	E	4	100	4	0
Semester 1 - Total credit: 12						

Unit I [15 Hours]

Introduction to Computer Science Research: Meaning of research, aims, nature and scope of research, prerequisites of research, types of research- fundamental/ pure research, applied and action research. Research problem, meaning of research problem, sources of research problem, characteristics of research problem, techniques involved in defining research problems, hypothesis and types, preparation of research proposal or synopsis. Methods of research studies- qualitative and quantitative. Research design, need for research design and its features, different research designs.

Research Design: Definition, Need, Features, and Types of Research Design: Classification: Exploratory Research, Descriptive Research, Causal Research, Relationships

Literature Survey: review of related literature, purpose of the review, identification of related literature, organization of related literature.

Unit II [15 Hours]

Sampling design, measurement and scaling techniques: sampling, its need, sampling fundamentals, important sampling distributions, census and sample survey, implications of a sample design, steps in sample design, criteria of selection sampling procedures, characteristics of sample design, different types of sampling design. Measurement scales, sources of errors in measurement, tests of sound measurement. Scaling, classifications bases for scales, importance of scaling techniques, scale constructions techniques. Comparative and Non-comparative Scaling Techniques.

Data collection, processing and analysis: Collection of primary data and secondary data, different tools for collecting data. Processing operations, frequently encountered problems in processing, data analysis, statistics in research and statistical measures, analysis of variance and covariance.

Fieldwork: The Nature of Fieldwork, Fieldwork/Data Collection Process, Selection of Field Workers, Training of Field Workers.

Report Preparation and Presentation: Report Format, Report Writing, Guidelines for Tables, Guidelines for Graphs.

Unit III [15 Hours]

Correlation and Regression: Multiple and Partial Correlation, Method of Least Squares, Plane of Regression, Properties of Residuals, Coefficient of multiple correlation, Coefficient of partial correlation, Multiple correlation with total and partial correlations, Regression and Partial correlations in terms of lower order co-efficient.

Multivariate Analysis: Random vectors and Matrices, Mean vectors and Covariance matrices, Multivariate Normal density and its properties, Principal components: Population principal components, Principal components from standardized variables.

Unit IV [15 Hours]

Testing of hypothesis: hypothesis, concepts in hypothesis testing, procedure for hypothesis testing, flow diagram for hypothesis testing, parametric and non-parametric tests, types.

Scientific Writing: Introduction to the tools of scientific writing, Significance of scientific Writing, Different Steps in scientific Report, Layout of the scientific Reports, Oral Presentation, Mechanics of Writing a Research Proposal.

Text books:

1. Kothari, C. R., "Research Methodology: Methods and Techniques", New Age International Publishers, Second Edition, 2004.
2. Gupta, S.C., and Kapoor, V.K., "Fundamentals of Mathematical Statistics", Sultan Chand and Sons, Eleventh Edition, 2002.
3. Taylor, B, Sinha, G., Ghoshal, T., "Research Methodology: A Guide for Researchers in Management and Social Sciences", Prentice-Hall of India Private Limited, New Delhi, 2006
4. Krishnaswamy, K. N., "Management Research Methodology : Integration of Principles, Methods and Techniques", Pearson, 2009
5. Kumar, R., "Research Methodology: A Step-By-Step Guide For Beginners", 4Th Edition, Sage Text, 2014

Reference Books:

1. Freund, J.E., "Mathematical Statistical", 5th Edition, Prentice Hall of India, 2001.
2. Devore, J.L., "Probability and statistics for Engineering and the Sciences", 5th Edition, Thomson and Duxbury, Singapore, 2002.
3. Creswell, J.W., "Research Design: Qualitative, Quantitative, and Mixed Methods Approaches", 2nd Edition, SAGE Publications, 2002.
4. C.George Thomas, C.G.," Research Methodology and Scientific Writing", Ane Books Pvt. Ltd., 2015

4 credits will be assigned to a non-lecture based paper in which the candidates review the literature and write a research proposal in the area of their research interest, and give a seminar at the end of the semester. There will be no sessional tests and no attendance requirement for this paper. They will be awarded marks out of 50 for the research proposal and 50 for the presentation and defense. At least one external member from within the School and two faculty members of the concerned department will constitute the evaluation committee for this paper.

Unit I [15 Hours]

Introduction to remote sensing and Basic Concepts: Remote sensing, Passive and active remote sensing, Basic concepts of remote sensing, different types of sensors, Electromagnetic spectrum, Energy sources and radiation principles, Effects of atmosphere Energy interaction with surface features, Spectral reflectance of vegetation, soil ,and water, atmospheric influence on spectral response patterns.

Unit II [15 Hours]

Remote Sensing Systems and Data Acquisition: Satellites and orbits, Polar orbiting satellites, Spectral, radiometric and spatial resolutions, Temporal resolution of satellites, Types of Platforms – different types of aircrafts-Manned and Unmanned spacecrafts, sun synchronous and geo synchronous satellites, Types and characteristics of different platforms, across track and along track scanners, multi spectral scanners and thermal scanners.

Unit III [15 Hours]

Application of Digital Image Processing in Remote Sensing: Image Restoration, Image Enhancement and Information Extraction, Geometric corrections, Co-registration of Data, Ground Control Points (GCP), Atmospheric corrections, Solar illumination corrections. Concept of color, Color composites, Contrast stretching – linear and non- linear stretching, Filtering techniques, Edge enhancement, Density slicing, Thresholding, Intensity-Hue-Saturation (IHS) images. Multispectral classification, Ground truth collection, Supervised and unsupervised classification, Change detection analysis, Principal component analysis.

Thermal Radiation Principles and Thermal Imaging: Thermal remote sensing– thermal sensors, principles, thermal data processing, applications.

Unit IV [15 Hours]

Data Analysis: Resolution- Spatial, Spectral, Radiometric and temporal resolution- signal to noise ratio- data products and their characteristics.

Applications of Remote Sensing: Remote sensing of soils and geomorphology, Remote Sensing of vegetation, Remote sensing of water resources and Urban applications using remote sensing imagery.

Text Books:

1. Lillesand, T.M., and Kiefer. R.W, "Remote Sensing and Image interpretation", VI edition of John Wiley & Sons-2000.
2. Elachi, C., Jakob J. van Zyl, "Introduction To The Physics and Techniques of Remote Sensing", Wiley Series in Remote Sensing and Image Processing, 2006.
3. Paul Curran, P.J., "Principles of Remote Sensing", ELBS; 1995.
4. Sabins, F.F. Jr, "Remote Sensing Principles and Image interpretation", W.H.Freeman & Co, 1978.
5. Schowengerdt, R. A., "Remote Sensing: Models and Methods for Image Processing", Academic Press, 2007.

Reference Books:

1. Jensen, J.R., "Introductory Digital Image Processing: A Remote Sensing Perspective", 2nd Edition, 1995.
2. Richards, J.A., Springer –Verlag, "Remote Sensing Digital Image Analysis", 1999.
3. Rees, W.G., "Physical Principles of Remote Sensing" 3rd Edition, Cambridge University Press, 2013
4. Campbell, J. B., Wynne, R. H., "Introduction to Remote Sensing", Guilford Press, 2011
5. Kumar, S., "Basics of Remote Sensing and GIS", Firewall Media, 2005

PCA-RS-E104: Geographic Information System **L:4,P:0, Credit: 4**

Unit I [15 Hours]

Introduction: definition, historical perspective, components of GIS and types of GIS. Technology trends in GIS, relationship between geoinformatics, information technology and sensor technology, distributing computing (cloud GIS, SDI).Concept of data. geographic data sources (Remote Sensing, GPS, maps and Field Observations). Introduction to spatial decision problem, decision sport system, overview of internet GIS, location based services.

Unit II [15 Hours]

Models and database management: Data models: Concept and types, Raster data model, Vector data model. Data input: methods, data quality, data errors, data editing. Databases: Database concepts, development, implementation and design. Database management system (DBMS): Network DBMS, Hierarchical DBMS, Relational DBMS, object oriented DBMS.

Unit III [15 Hours]

Interpolations, geospatial analysis and Digital elevations model: Introduction to interpolation, types of interpolation, methods for interpolation: these in polygons, inverse distance, weighted splines and krigging. Geospatial analysis: introduction, vector-based analysis and raster-based analysis. Digital Elevation Model (DEM): definition, methods of development, and applications of DEM. Network analysis: concept and models.

Unit IV [15 Hours]

Global positioning system: Basic concepts of Global Positioning System (GPS), accuracy and error corrections in GPS. Fundamental of mobile mapping, application of GPS in resources surveys and mapping. Concept of absolute and differential global positioning system. Types of GPS receivers, GPS satellite signal, GPS data, error correction techniques in GPS. Introduction to IRNSS.

Applications of GIS: Utility mapping using GIS, land suitability analysis. GIS for environmental impact analysis (EIA).Disaster vulnerability analysis (landslide hazard zonation).geospatial modeling: introduction, importance and techniques, land degradation modelling.

Text Books:

1. Heywood, I., Cornelius, S., Carver, S., Raju, S., “An Introduction to Geographical Information Systems”, 2nd Edition, Pearson Education, 2010.
2. Bhatta, B., “Remote Sensing and GIS”, Oxford University Press, 2008.
3. Demers, M.N., “Fundamentals of Geographic Information Systems” John Wiley and Sons, Inc, 2008.
4. Burrough, P. A., McDonnell, R.A.," Principles of Geographical Information Systems (Spatial Information Systems)", Oxford University Press, 2015.
5. Clarke, K.C., Parks, B. O., Crane, M. P., Parks, B. E., ”Geographic Information Systems and Environmental Modeling”, Prentice Hall, 2002.

Reference Books:

1. Burrough, P.A.,”Geographic Information Systems for Land Resources Assessment” Oxford: Oxford University Press, 1994.
2. Laurini, R., Thompson, D., “Fundamentals of Spatial Information Systems” Academic Press London, 1992.
3. Chou, Y. H.,”Exploring Spatial Analysis In Geographical Information Systems”, Onward Press, New Mexico, US, 1997.
4. Chang, K.,T., "Introduction to Geographic Information Systems", McGraw Hill, 2015.
5. Pourabbas, E., "Geographical Information Systems: Trends and Technologies", CRC Press, 2014

PCA-RS-E105: Digital Image Processing **L:4,P:0, Credit: 4**

Unit I [15 Hours]

Introduction: Introduction: Digital Image, Fundamental steps in Image Processing, Elements of DIP systems, Simple Operations- Arithmetic, Logical, Geometric Operations.

Digital Image Fundamentals: Elements of Visual Perception, Sampling and Quantization, Relationships between pixels, Linear and Nonlinear operations.

Unit II [15 Hours]

Image Enhancement in Spatial domain: Enhancement by Point Processing, Histogram Processing, Spatial Filtering.

Image Enhancement in Frequency Domain: Introduction to the Fourier Transform, The discrete Fourier Transform, Properties of the two-dimensional Fourier Transform, Smoothing Frequency-domain filters, Sharpening Frequency domain filters.

Image restoration and construction: Image Restoration: Image Observation and Degradation Model, Circulant and Block Circulant Matrices and Its Application in Degradation Model, Algebraic Approach to Restoration, Inverse by Wiener Filtering, Generalized Inverse-SVD And Interactive Methods, Blind Deconvolution, Image reconstruction from projections.

Unit III [15Hours]

Image Compression: Fundamentals, Image Compression Models, Error Free Compression, Lossy Compression.

Image Segmentation: Edge Detection, Line Detection, Curve Detection, Edge Linking and Boundary Extraction, Boundary Representation, Region Representation and Segmentation, Morphology-Dilation, Erosion, Opening and Closing, Hit and Miss Algorithms feature analysis.

Unit IV [15 Hours]

Color and multispectral image processing: Color Image Processing Fundamentals, RGB Models, HSI Models, Relationship Between Different Models, Multispectral Image Analysis.

Object Recognition: Patterns and Pattern Classes, Recognition based on Decision- theoretic methods, structural methods.

Text Books:

1. Gonzalez, R. C., Woods, R. E., “Digital Image Processing”, Pearson, 2009.
2. Castleman, K. R., “Digital Image Processing”, Pearson Education, 1995.
3. Shinghal, R., “Pattern Recognition”, Oxford Publications, 1992.

4. Umbaugh, S.,E., "Digital Image Processing and Analysis: Human and Computer Vision Applications with CVIPtools", CRC Press, 2010.
5. Solomon, C., Breckon, T., ”Fundamentals of Digital Image Processing A Practical Approach with Examples in Matlab”, Wiley-Blackwell, 2011.

Reference Books:

1. Chanda, B., Majumder, D. D., “Digital Image Processing and Analysis”, Prentice Hall Publications, 2011.
2. Gonzalez, R. C., Woods, R. E., “Digital Image Processing with Matlab”, Pearson, 2013.
3. Sridhar, S., “Digital Image Processing”, Oxford University Press, 2011.
4. Jayaraman, S.,, “Digital Image Processing”, McGraw Hill, 2011.

Unit I [15 Hours]

Network Layer: IP Protocol: Datagram-fragmentation, IP package, IP Addresses: Classful addressing, subnetting, supernetting, Classless addressing, Routing Protocols for Wired Network: Unicast Routing Protocols: Shortest Path, Flooding, DVR, Link State Routing, Multi Cast Routing Protocols, Interior Gateway Protocol
:OSPF, Exterior Gateway Protocol : BGP, multi-path and type –of-service routing, quality-of-services routing –routing heuristics for GS, Internet QoS routing, fast routing/ switching

Unit II [15 Hours]

Mobile Network Layer: Mobile IP: IP packet deliver-Agent advertisement and discovery, Registration, Tunnelling and Encapsulation, Reverse tunnelling, Cellular Network, HAWAII, Mobile IPv4, Mobile IPv6, HMIPv6, MAP Discovery, Local Mobility Management in HMIPv6, dynamic host configuration protocol, Ad hoc networks: Routing- Destination sequence distance vector, Dynamic source routing, Hierarchical algorithms, Alternative metrics.

Unit III [15 Hours]

Transport Layer: Services- Congestion control, Reliable service, TCP features- TCP segment-TCP connection-flow control error control- congestion control-TCP variants –Tahoe- Reno- Vegas- new – Reno- SACK, Connectionless UDP: Use of UDP, Header Description, Real-time Transport Protocol (RTP), SCTP, Wireless TCP, SNOOP, Mobile Transport Layer: Traditional TCP: Congestion control, Implications on mobility: Mobile TCP, Transmission / time-out freezing, selective retransmission, Transaction oriented TCP.

Unit IV [15 Hours]

Application Layer: Domain Name Systems, E-mail system, WorldWide Web:- Architectural Overview, HTTP, SNMP, Performance Enhancements, multimedia and adaptive applications, voice and video over IP, real time transport protocols, scalable and QoS-aware servers, web proxy coaching Network Security: Cryptography, Symmetric Key Algorithms: - DES, Public Key Algorithms: - RSA. Digital Signatures: -Symmetric Key Signatures, Public Key Signatures, Message Digests.

Text Books:

1. Tanenbaum, A.S., “Computer Networks”, PHI, 2011.
2. Forouzan, B. A., “Introduction to Data Communication and Networking”, Mc Graw

Hill, 2007.
3. Bagad, V.S., "Advanced Computer Networks" Technical Publications, 2010.
4. Jain,S., "Advanced Computer Networking: Concepts and Applications", BPB Publications, 2006.
5. Peterson, L.L, Davie, B.S., "Computer Networks: A Systems Approach", Morgan Kaufmann, 2011.

Reference Books:

1. Stalling, W., “Data and Computer Communications”, PHI, 2007.
2. Soliman, H., “Mobile IPv6 Mobility in a Wireless Internet”, Pearson Education, 2004.
3. Forouzan, B. A., Mosharraf, F., "Computer Networks: A Top-Down Approach", Mc Graw Hill, 2011.
4. Ciubotaru, A., Muntean, G. M, "Advanced Network Programming - Principles and Techniques: Network Application Programming with Java", Springer, 2013.
5. Kurose, J., Ross, K., “Computer Networking: A Top-Down Approach”, Pearson Education, 2010.

PCA-RS-E107: Wireless Sensor Networks **L:4,P:0, Credit: 4**

Unit I [15 Hours]

Introduction: Basics of Wireless Sensor Networks (WSNs) and its Applications, Design Issues: Energy, Self-Management, Wireless Networking, Decentralized Management, Security, Clustering of Sensors, Difference Between WSNs and Ad Hoc Wireless Networks.

Node Architecture and Operating System: Sensor Node Architecture, IMote node architecture, Operating System: TinyOS, Imperative Language: nesC, Dataflow Style Language: TinyGALS, Node-Level Simulators.

Unit II [15 Hours]

Communication Protocols: Physical Layer: Basic Components, Source Encoding, Channel Encoding, Medium Access Control: Wireless MAC Protocols, Contention-Free MAC Protocols, Contention-Based MAC Protocols, Hybrid MAC Protocols, Network Layer: Categories of Routing Protocol, Routing Metrics, Flooding and Gossiping, Data- Centric Routing, Proactive Routing, On-Demand Routing, Hierarchical Routing, Location-Based Routing.

In-Network Information Processing: Introduction, Communication Complexity Model, Comparing Functions over Wireless Networks; Special Reuse and Block Computation, Law of Sensor Network Lifetime and Its Applications.

Unit III [15 Hours]

Power Management and Time Synchronization: Local Power Management, Dynamic Power Management, Clocks and Synchronization Problem, Temporal Data.

Localization: Ranging Techniques, Range-Based Localization, GPS-Based Localization, Range-Free Localization, Event-Driven Localization.

Distributed Learning and Estimation: Introduction, Classical Learning, Fusion Center, Distributed Estimation under Bandwidth and Energy Constrains.

Unit IV [15 Hours]

Graphical Models and Fusion Sensor Networks: Introduction, Graphical Models, from Sensor Network Fusion to Graphical Models, Approximation and Impact on Fusion.

Security: Fundamentals of Network Security, Challenges of Security in Wireless Sensor Networks, Security Attacks in Sensor Networks, Protocols and Mechanisms for Security, IEEE 802.15.4 and Zigbee Security.

Text Books:

1. Dargie, W., Poellabauer, C., "Fundamentals of Wireless Sensor Networks: Theory and Practice", Wiley Publication, 2010.
2. Zheng, J., Jamalipour, A., "Wireless Sensor Networks: A Networking Perspective", Wiley Publication, 2009.
3. Swami, A., "Wireless Sensor Networks: Signal Processing and Communication Perspectives", John Wiley, 2007.

Reference Books:

3.1. Zhao, F., Guibas, L., "Wireless Sensor Networks: An Information Processing Approach", Elsevier Publication, 2004.

3.2. Karl, H., Willig, A., "Protocols and Architectures for Wireless Sensor Networks", Wiley Publication, 2007.

3.3. Faludi, R., "Building Wireless Sensor Networks", O'Reilly Publication, 2010.

3.4. Farahani, S., "ZigBee Wireless Networks and Transceivers", Elsevier Publication, 2011.

3.5. Murthy, C., Murthy, B., "Adhoc Wireless Networks: Architectures and Protocols", Pearson Education, 2004

3.6. Hu, F., Cao, X., "Wireless Sensor Networks: Principles and Practice", An Auerbach Book, CRC Press, Taylor & Francis Group, 2010.

3.7. Sarkar, S., "Wireless Ad hoc Mobile Wireless Networks: Principles, Protocols and Applications", Auerbach Publications, Taylor & Francis Group, 2007.

PCA-RS-E108 Data Analytics **L:4,P:0, Credit: 4**

Unit I [15 Hours]

Introduction: Introduction to data analytics (DA), data preparation, and data cleaning, Big Data Overview, What is data sciences, the rising and importance of data sciences, Big data analytics in industry.

Data Analytics Lifecycle and methodology: Understanding Business Data, Data Preparation, Data Modelling, Data Evaluation, Communicating results, Deployment of Data.

Unit II [15 Hours]

Statistical Analysis: Basic statistical concepts. Mean, standard deviation. Rank statistics and percentiles, Distributions, Covariance, correlation, analysis of variance, Statistical tests, confidence and hypothesis testing, Tools such as R.

Probabilistic Analysis: Dependence and Independence, Conditional Probability, Bayes's Theorem, Random Variables Continuous Distributions, The Normal Distribution, The Central Limit Theorem, For Further Exploration.

Unit III [15 Hours]

Data Analytics: Theory & Methods: Data features, Classification, Supervised and unsupervised learning, Supervised learning - Linear/Logistic regression, Decision trees, Naïve Bayes, Unsupervised learning - K-means clustering, Association rules, Clustering algorithms. Knowledge discovery. Anomaly detection.

Hypothesis and Inference: Statistical Hypothesis Testing, Example: Flipping a Coin, Confidence Intervals, P-hacking, Example: Running an A/B Test, Bayesian Inference.

Unit IV [15 Hours]

Tools for Data Analytics: Globally distributed data stores, Tools for big data, Introduction to Hadoop, HDFS, MapReduce, YARN, HBase, Hive, Pig, Sqoop, Zookeeper, Flume, NoSQL.

Data Representation and Analysis: Log Data Analysis – HDFS scenario: Write once & Read often, Data Warehouse, Fraud Detection, Risk Modeling, Social Sentiment Analysis, Image Classification, Graph Analysis.

Text Books:

3.7.1. Larose, D. T., Larose, C. D., "Discovering Knowledge in Data: An Introduction to Data Mining", Wiley 2nd Edition, 2005.

3.7.2. Klimberg, R., McCullough, B. D., "Fundamentals of Predictive Analytics with JMP", SAS Institute Publishers, 2013.

Reference Books:

1. EMC Education Services, "Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data" Wiley Publications.
2. Grus, J., "Data Science from Scratch First Principles with Python", O'Reilly Media, 2015.