BRAINWARE UNIVERSITY
SCHOOL OF COMPUTATIONAL & APPLIED SCIENCES
DEPARTMENT OF COMPUTATIONAL SCIENCES
PH. D. IN SCIENCE (COMPUTER SCIENCE)

Course Code	Course Name	L - T - P	Credit	Total Marks
PHD – RM01	Research Methodology	4-0-0	4	100
PHD – RPE01	Research and Publication Ethics	2-0-0	2	100
PHD – CSS01	A. Internet of Things and Applications B. Advanced Cloud Computing	3-0-0	3	100
PHD – CSS02	Subject Based (Internet of Things and Applications / Advanced Cloud Computing) Case Study Report and Presentation	3-0-0	3	100
	Total	**12**	**12**	**400**

BRAINWARE UNIVERSITY
SCHOOL OF COMPUTATIONAL & APPLIED SCIENCES
DEPARTMENT OF COMPUTATIONAL SCIENCES
PH. D. IN SCIENCE (COMPUTER SCIENCE)

Course Code: PHD – RM01
Course Name: Research Methodology
Contact: 4L
Credit: 4
Allotted Hours: 60

Course Objective: The primary goal of this course is to introduce the fundamental ideas of research methodology. It discusses the methods and tools that should be used to complete a research project as well as the problems that arise when choosing a research problem. This will also enable the students to prepare report writing.

Pre-requisite*:* Basic understanding about Research Methodology

Course Outcomes: Upon completion of this course, the student shall be able to
CO1: Understand various statistical packages and analyze the sampling techniques to create competency in research techniques.
CO2: Formulate research problem and compare various measurement models to develop proficiency in judging research accuracy.
CO3: Design experimental hypothesis through computational techniques and analyze data through model adequacy checking
CO4: Evaluate various qualitative research methods and analyze various case studies through concept and correlation analysis

Module I: Introduction to Research **[12H]**
Methodology and Method, Types of research- Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical, Concept of Interdisciplinary Research, Procedures in research, Identification of the problem- Literature survey, Experimental methods, Quasi-experimental studies-Survey, type of surveys - CATI, CAPI, Mail, Email, Face-to-face, Questionnaire, Discourse analysis, Biographical Data Analysis.

Module II: Sampling and Analysis **[12H]**
Primary and secondary data, Collection and validation, Methods of sampling- Simple random sampling. Stratified random sampling and Systematic sampling, Attitude Measurement- land Scales, Scaling of attitude, Deterministic attitudes, Measurement models, Summative models.

BRAINWARE UNIVERSITY
SCHOOL OF COMPUTATIONAL & APPLIED SCIENCES
DEPARTMENT OF COMPUTATIONAL SCIENCES
PH. D. IN SCIENCE (COMPUTER SCIENCE)

Module III: Experimental design and Hypothesis [12H]

Factorial experimental design, designing experiments, Basic principles-replication, randomization, blocking. Single Factor Experiment: Hypothesis design, Hypothesis testing using z- test, t-test, ANOVA etc., Analysis of Variance Components (ANOVA) for fixed effect model, Sum of squares of treatments (SST), Sum of squares of error (SSE), Degrees of freedom, Confidence interval, ANOVA for random effects model, Model adequacy checking.

Module IV: Data Collection and Management [06H]

Data Collection, Data Extraction, Data Cleansing, Data Sanity and Data Security.

Module V: Computer Application [08H]

Introduction to spread sheet application, Features and functions, using formulas and functions, Data storing. Features for Statistical data analysis, Generating charts/ graph and other features, Power point presentation. Use of software for statistical analysis such as SPSS.

Module VI: Research Report [10H]

Type of research report- contents, Steps in drafting, Editing, and evaluating the final draft, Styles for figures, tables, text, quoting of reference and bibliography, Use and format of appendices- Indexing, Structure and presentation of research report, Research ethics, plagiarism.

Reference books:

1. Legal Research Methodology by Manoj Kumar Sinha, Deepa Kharb, LexisNexis, 1st Edition, 2017
2. Research Methodology Methods and Techniques by C.R. Kothari, Gaurav Garg, New Age Publisher, 04th Edition, 2019
3 Fundamentals of Modern Statistical Methods: Substantially Improving Power and Accuracy by Rand R. Wilcox, Springer, 2nd Edition, 2010
4 Design and Analysis of Experiments by Douglas C. Montgomery, John Wiley & Sons Inc., 8th Edition, 2012.
5 The Data Book: Collection and Management of Research Data by Meredith Zozus, Chapman and Hall/CRC; 1st edition, 2017

BRAINWARE UNIVERSITY
SCHOOL OF COMPUTATIONAL & APPLIED SCIENCES
DEPARTMENT OF COMPUTATIONAL SCIENCES
PH. D. IN SCIENCE (COMPUTER SCIENCE)

Course Code: PHD – RPE01
Course Name: Research and Publication Ethics
Contact: 2L
Credit: 2
Allotted Hours: 30

Course Objective: This course aims to educate research applicants on the philosophy of research, research and publishing ethics, accessibility of papers, and publication misconduct. To find publications that are predatory and engage in dishonest research. to comprehend citation and indexing databases, open access papers, and research metrics (citations, h-index, impact Factor, etc.).

Pre-requisite*:* Basic understanding about ethical neutrality on publication and copyright issues.

Course Outcomes: Upon completion of this course, the student shall be able to
CO1: Develop awareness of research philosophy and illustrate the ethical judgements in research
CO2: Predict the concepts of publication ethics through best practices standards and identify publication misconduct through computational techniques.
CO3: Identify various Journals and Publishers to explore the research work in the appropriate area
C04: Prepare scientific reports and formulate project proposal to develop competency in designing funding proposals.

Module I: Philosophy of Ethics **[10H]**

1. Ethics with respect to science and research.
2. Intellectual honesty and research integrity.
3. Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP).
4. Redundant publications: duplicate and overlapping publications.
5. Selective reporting and misrepresentation of data.

BRAINWARE UNIVERSITY
SCHOOL OF COMPUTATIONAL & APPLIED SCIENCES
DEPARTMENT OF COMPUTATIONAL SCIENCES
PH. D. IN SCIENCE (COMPUTER SCIENCE)

Module II: Publication Ethics **[10H]**

1. Publication ethics: definition, introduction and importance.
2. Conflicts of interest.
3. Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types.
4. Violation of publication ethics, authorship and contributorship.
5. Identification of publication misconduct, complaints and appeals.
6. Predatory publishers and journals PRACTICE.
7. Techniques of paraphrasing.

Module III: Research Metrics **[10H]**

A. Software tools
Use of plagiarism software like Turnitin, Urkund.

B. Databases
Indexing databases, Citation databases: Web of Science, Scopus, etc.

C. Research Metrics
Impact Factor of journal as per Journal Citation Report, SNIP, SJR, IPP, and Cite Score. Metrics: h-index, g index, i10 index, altimetric.

Reference books:

1. The Ethics of Teaching and Scientific Research, Sidney Hook, Paul Kurtz, and Miro Todorovich, Prometheus Books, 1977
2. Research Ethics: A Psychological Approach, Barbara H. Stanley, Joan E. Sieber, Gary B. Melton, University of Nebraska Press, 1996
3. Research Methods in Applied Settings: An Integrated Approach to Design and Analysis, Jeffrey A. Gliner, George A. Morgan, Nancy L. Leech, Routledge, 2nd Edition, 2009
4. Ethics and Values in Industrial-Organizational Psychology by Joel Lefkowitz Lawrence Erlbaum Associates, 2003.

Note: **Latest references will be added by the teaching faculty during the class**

BRAINWARE UNIVERSITY
SCHOOL OF COMPUTATIONAL & APPLIED SCIENCES
DEPARTMENT OF COMPUTATIONAL SCIENCES
PH. D. IN SCIENCE (COMPUTER SCIENCE)

Course Code: PHD – CSS01A
Course Name: Internet of Things and Applications
Contact: 3L
Credit: 3
Allotted Hours: 45

Course Objective: The Internet of Things (IoT) is currently a popular technology in several countries. Different facets of IoT research, application, and business are engaged in by the government, academia, and industry. IoT is applicable to a wide range of industries, from the defense to the civil ones. The transfer of their legacy infrastructure to accommodate IoT is currently taking place in these fields, which also include manufacturing, healthcare, water, mining, and agriculture. Pervasive connectivity, storage, and processing are now conceivable, which opens the door to developing various IoT solutions.

Pre-requisite*:* Basic programming knowledge.

Course Outcomes: Upon completion of this course, the student shall be able to
CO1: Discuss and Construct the architectural principles used to design the Internet of Things.
CO2: Classify and distinguish various sensors and technologies to connect with network.
CO3: Differentiate and classify the most appropriate connectivity technologies for different application scenarios.
CO4: Demonstrate and Compose Internet of Things systems based on the Arduino Programming.
CO5: Illustrate and Design the technologies, standards, and protocols appropriate to IoT.
CO6: Interprete sensor technologies for sensing real world entities and Reframe the role of IoT in various domains of Industry.

Module I: Introduction to Internet of Things [09H]

Introduction- The IOT Today & Progression to Tomorrow – Success Factors –Strategic Research & Innovation Directions. Sensing – Sensors, Transducers, Sensor Features, Resolution, Hysteresis Error. Actuation – Hydraulic, Pneumatic, Electrical, Thermal/ Magnetic, Mechanical Actuators. Functional Components of IoT - Component for interaction and communication with other IoT devices, processing and analysis of operations, Internet interaction, handling Web services of applications, integrate application, interface to access IoT services.

BRAINWARE UNIVERSITY
SCHOOL OF COMPUTATIONAL & APPLIED SCIENCES
DEPARTMENT OF COMPUTATIONAL SCIENCES
PH. D. IN SCIENCE (COMPUTER SCIENCE)

Module II: Basics of IoT Networking and Sensor Networks [09H]

Connectivity Technologies - 6LoWPANs, Introduction to RFID, IoT Data Protocol, MQTT, SMQTT, CoAP, XMPP, AMQP, Wireless Multimedia Sensor Networks, Nano networks, WSN Coverage, Stationary Wireless Sensor Networks, Mobile Wireless Sensor Networks, UAV Networks, MANETs, FANETs, VANETs

Module III: Communication Protocols [09H]

Communication Protocols - IEEE 802.15.4, Zigbee, HART & Wireless HART, NFC, Bluetooth, Z WAVE, Wireless Sensor Networks, Node Behavior in WSNs. Layer Connectivity: Wireless Technologies for the IoT-WPAN Technologies for IoT/M2M, Cellular and Mobile Network Technologies for IoT/M2M, Layer 3 Connectivity: IPv6 Technologies for the IoT: Overview and Motivations. Address Capabilities, IPv6 Protocol Overview, IPv6 Tunneling, IPsec in IPv6, Header Compression Schemes, Quality of Service in IPv6, Migration Strategies to IPv6.

Module IV: Software-Defined Networking [08H]

SDN –restructuring current network infrastructure, SDN Architecture, Architecture of SDN – Application, Control and Infrastructure layers, Components/Attributes of SDN, OpenFlow protocol –flow-rule and math-fields, Software-Defined WSN, Integrating SDN in IoT, SDN-WISE Protocol Stack

Module V: Interoperability in IoT [04H]

Interoperability, Interoperability is Important in Context of IoT, Types of Interoperability - User Interoperability, Device Interoperability, Semantic Interoperability for Device Interaction

Module VI: Case Study Implementation [06H]

Arduino Programming - Operators in Arduino, Control Statement, Loops, Arrays, String, Math Library, Random Number, Interrupts and Approach to presentation delivery in a seminar. Arduino programming with a proper implementation of case study

BRAINWARE UNIVERSITY
SCHOOL OF COMPUTATIONAL & APPLIED SCIENCES
DEPARTMENT OF COMPUTATIONAL SCIENCES
PH. D. IN SCIENCE (COMPUTER SCIENCE)

REFERENCE BOOKS:

1. "Internet of Things – From Research & Innovation to Market Deployment", Ovidiu Vermesan, Peter Friess, River Publishers, 2014
2. "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stamatis Karnouskos, Stefan Avesand, David Boyle, Elsevier Ltd, 2014
3. "Internet of Things – A hands-on approach", Arshdeep Bahga, Vijay Madisetti, Universities Press, 2015.
4. "Intel® Galileo and Intel® Galileo Gen 2: API Features and Arduino Projects for Linux Programmers", Manoel Carlos Ramon, Apress, 2014.
5. "Internet of Things with the Arduino Yun", Marco Schwartz, Packt Publishing, 2014

BRAINWARE UNIVERSITY
SCHOOL OF COMPUTATIONAL & APPLIED SCIENCES
DEPARTMENT OF COMPUTATIONAL SCIENCES
PH. D. IN SCIENCE (COMPUTER SCIENCE)

Course Code: PHD – CSS01B
Course Name: Advanced Cloud Computing
Contact: 3L
Credit: 3
Allotted Hours: 45

Course Objective: A wide range of businesses and industries are utilizing cloud computing services. Cloud computing is simply the supply of computing as a service through a network, whereby distributed resources are rented, rather than owned, by an end user as a utility. This domain will be introduced, and subjects like cloud infrastructures, virtualization, software defined networks and storage, cloud storage, and programming models will all be covered in the course. We will explore service models, security, illustrative cloud service providers, use cases, and the drivers, advantages, and difficulties of the cloud as an introduction.

Pre-requisite*:* Understanding of programming, debugging, and computer systems.

Course Outcomes: Upon completion of this course, the student shall be able to
CO1: Illustrate and Differentiate the concept of cloud and types of computing.
CO2: Explain and Distinguish various service-oriented architecture and deployment model.
CO3: Design and Implement various virtualization technologies in cloud platform.
CO4: Validate the security issues in cloud and infer security oversight.
CO5: Analyze and Formulate report on variety of cloud management solutions.
CO6: Assess and Construct writing skills imbibe with accurate formatting and academic Ethics.

Unit-I: Basic Concept of Cloud Computing [09H]

Basic Concept of computer network, Overview of Computing Paradigm, Recent trends in Computing: Grid Computing, Cluster Computing, Distributed Computing, Utility Computing, Cloud Computing. Evolution of cloud computing: Business driver for adopting cloud computing. Introduction to Cloud Computing: Cloud Computing (NIST Model), History of Cloud Computing, Cloud service providers and its Necessity; Properties, Characteristics & Disadvantages: Pros and Cons of Cloud Computing, Comparative study of Cloud, Cluster, Grid computing; Role of Open Standard Cloud

BRAINWARE UNIVERSITY
SCHOOL OF COMPUTATIONAL & APPLIED SCIENCES
DEPARTMENT OF COMPUTATIONAL SCIENCES
PH. D. IN SCIENCE (COMPUTER SCIENCE)

Unit-II: Cloud Computing Architecture **[09H]**

Cloud Computing Architecture: Cloud computing stack: Comparison with traditional computing architecture (client/server), The Workings of Cloud Computing, Role of Networks in Cloud computing, protocols used, Role of Web services; Service Models(Introduction, Functionality, Architecture, Advantage, Disadvantage and Application : XaaS, IaaS, PaaS, SaaS; Deployment Models: Public cloud, Private cloud, Hybrid cloud, Community cloud; Service Oriented Architecture (SOA)

Unit-III: Virtualization **[09H]**

Introduction to virtualization, Different approaches to virtualization and Load balancing, Hypervisors, Machine Image, Virtual Machine (VM). Resource Virtualization: Server, Storage, Network, Virtual Machine (resource) provisioning and manageability, storage as a service, Data storage in cloud computing (storage as a service); System virtualization technologies-architectures and internals. KVM, Xen, VMware, DEVOPS. Memory virtualization-virtualization techniques, ballooning, deduplication and sharing; Network and storage virtualization; Virtual machine migration and replication techniques pre-copy and post-copy techniques, applicability to system availability. Examples: Amazon EC2, Renting, EC2 Compute Unit, Platform and Storage, pricing, customers, Eucalyptus Cloud Platform and Management, Computation, Storage, Examples, Google App Engine, Microsoft Azure, Salesforce.com platform.

Unit-IV: Cloud Security **[09H]**

Cloud Security: Infrastructure Security: Network level security, Host level security, Application level security, Data security and Storage: Data privacy and security Issues, Jurisdictional issues raised by Data location, Identity & Access Management, Access Control, Trust, Reputation, Risk Authentication in cloud computing, Client access in cloud, Cloud contracting Model, Commercial and business considerations.

BRAINWARE UNIVERSITY
SCHOOL OF COMPUTATIONAL & APPLIED SCIENCES
DEPARTMENT OF COMPUTATIONAL SCIENCES
PH. D. IN SCIENCE (COMPUTER SCIENCE)

Unit- V: Review of various cloud management solutions [09H]

Discussion on various cloud management solutions, Comparative study on contemporary cloud tools and software's, Review-based Report preparation on Cloud Management Tooling and presentation in a seminar

REFERENCE BOOKS:

1. Cloud Computing Bible, Barrie Sosinsky, Wiley-India, 2010
2. Cloud Computing: Principles and Paradigms, Editors: Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, Wile, 2011.
3. Cloud Computing: Principles, Systems and Applications, Editors: Nikos Antonopoulos, Lee Gillam, Springer, 2012
4. Cloud Security: A Comprehensive Guide to Secure Cloud Computing, Ronald L. Krutz, Russell Dean Vines, Wiley-India, 2010

BRAINWARE UNIVERSITY
SCHOOL OF COMPUTATIONAL & APPLIED SCIENCES
DEPARTMENT OF COMPUTATIONAL SCIENCES
PH. D. IN SCIENCE (COMPUTER SCIENCE)

Course Code: PHD – CSS02
Course Name: Subject Based (Internet of Things and Applications / Advanced Cloud Computing) Case Study Report and Presentation
Contact: 3L
Credit: 3
Allotted Hours: 45

Course Objective: An activity course involving practical experience in planning a research investigation, designing questionnaires, sampling, interpreting results and preparing a research report. Students will grow a critical awareness of research issues, methodologies, and methods used in business and management and an understanding of potential ethical problems of the research.

Pre-requisite*:* Knowledge on documents handling.

Course Outcomes: Upon completion of this course, the student shall be able to
CO1: To know the basic data collection methods with emphasis on secondary and compose research.
CO2: To obtain skills to handle primary data and data handling instruments and develop skills on field works and its various techniques.
CO3: To be able to compile basic samples for use in studies research and validate how and when to use different sampling techniques.
CO4: To understand and validate the relevance of basic data analysis techniques.

Case study and finding the gaps in the existing literature and comparative analysis and design a detailed report. To prepare a presentation and delivery it in a seminar.