RV COLLEGE OF ENGINEERING®

(Autonomous Institution Affiliated to VTU, Belagavi)

R.V. Vidyaniketan Post, Mysore Road

Bengaluru – 560 059

Bachelor of Engineering (B.E.)

Scheme and Syllabus for VII & VIII Semesters

2016 SCHEME

COMPUTER SCIENCE AND ENGINEERING

VISION

Leadership in Quality Technical Education, Interdisciplinary Research & Innovation, with a Focus on Sustainable and Inclusive Technology

MISSION

1. To deliver outcome based Quality education, emphasizing on experiential learning with the state of the art infrastructure.
2. To create a conducive environment for interdisciplinary research and innovation.
3. To develop professionals through holistic education focusing on individual growth, discipline, integrity, ethics and social sensitivity.
4. To nurture industry-institution collaboration leading to competency enhancement and entrepreneurship.
5. To focus on technologies that are sustainable and inclusive, benefiting all sections of the society.

QUALITY POLICY

Achieving Excellence in Technical Education, Research and Consulting through an Outcome Based Curriculum focusing on Continuous Improvement and Innovation by Benchmarking against the global Best Practices.

CORE VALUES

Professionalism, Commitment, Integrity, Team Work, Innovation

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2016 SCHEME

DEPARTMENT OF
COMPUTER SCIENCE AND ENGINEERING

Department Vision

To achieve leadership in the field of Computer Science & Engineering by strengthening fundamentals and facilitating interdisciplinary sustainable research to meet the ever-growing needs of the society**.**

Department Mission

- To evolve continually as a centre of excellence in quality education in computers and allied fields.
- To develop state-of-the-art infrastructure and create environment capable for interdisciplinary research and skill enhancement.
- To collaborate with industries and institutions at national and international levels to enhance research in emerging areas.
- To develop professionals having social concern to become leaders in top-notch industries and/or become entrepreneurs with good ethics.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO1: Develop Graduates capable of applying the principles of mathematics, science, core engineering and Computer Science to solve real-world problems in interdisciplinary domains.
PEO2: To develop the ability among graduates to analyze and understand current pedagogical techniques, industry accepted computing practices and state-of-art technology.
PEO3: To develop graduates who will exhibit cultural awareness, teamwork with professional ethics, effective communication skills and appropriately apply knowledge of societal impacts of computing technology.
PEO4: To prepare graduates with a capability to successfully get employed in the right role and achieve higher career goals or take up higher education in pursuit of lifelong learning.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO	Description
PSO1	**System Analysis and Design -** The student will:
	1. Recognize and understand the dynamic nature of developments in computer architecture, data organization and analytical methods
	2. Learn the applicability of various systems software elements for solving real world design problems.
	3. Identify the various analysis & design methodologies for facilitating development of high quality system software products with focus on performance optimization.
	4. Display good team participation, communication, project management and document skills.
PSO2	**Product Development -** The student will:
	1. Demonstrate knowledge of the ability to write programs and integrate them resulting in state of art hardware/software products in the domains of embedded systems, databases /data analytics, network/web systems and mobile products.
	2. Participate in teams for planning and implementing solutions to cater to business specific requirements displaying good team dynamics and professional ethics.
	3. Employ state of art methodologies for product development and testing / validation with focus on optimization and quality related aspects.

Lead Society: Institute of Electrical and Electronics Engineers

ABBREVIATIONS

SL. NO.	ABBREVIATION	MEANING
1.	VTU	Visvesvaraya Technological University
2.	BS	Basic Sciences
3.	CIE	Continuous Internal Evaluation
4.	SEE	Semester End Examination
5.	CE	Professional Core Elective
6.	GE	Global Elective
7.	HSS	Humanities and Social Sciences
8.	CV	Civil Engineering
9.	ME	Mechanical Engineering
10.	EE	Electrical & Electronics Engineering
11.	EC	Electronics & Communication Engineering
12.	IM	Industrial Engineering & Management
13.	EI	Electronics & Instrumentation Engineering
14.	CH	Chemical Engineering
15.	CS	Computer Science & Engineering
16.	TE	Telecommunication Engineering
17.	IS	Information Science & Engineering
18.	BT	Biotechnology
19.	AS	Aerospace Engineering
20.	PY	Physics
21.	CY	Chemistry
22.	MA	Mathematics

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COMPUTER SCIENCE AND ENGINEERING

SEVENTH SEMESTER CREDIT SCHEME

Sl. No.	Course Code	Course Title	BOS	Credit Allocation				Total Credits
				L	T	P	S	
1.	16CS71	Parallel Architecture & Distributed Programming	CS	3	0	1	0	4
2.	16CS72	Data Science and Machine Learning Essentials	CS	3	0	1	0	4
3.	16CS73	Computer Graphics	CS	3	0	1	0	4
4.	16CS7FX	Elective F	CS	4	0	0	0	4
5.	16CS7GX	Elective G	CS	4	0	0	0	4
6.	16G7HXX	Elective H (GE)*	Respective BOS	3	0	0	0	3
Total number of Credits				**20**	**0**	**03**	**0**	**23**
Total Number of Hours / Week				**20**	**00**	**6**	**00**	**--**

*Students should take other department Global Elective courses

EIGHTH SEMESTER CREDIT SCHEME

Sl. No.	Course Code	Course Title	BOS	Credit Allocation				Total Credits
				L	T	P	S	
1.	16CS81	Major Project	CS	0	0	16	0	16
2.	16CS82	Technical Seminar	CS	0	0	2	0	2
3.	16HS83	Innovation and Social Skills	HSS	0	0	2	0	2
Total No. of Credits				**0**	**0**	**20**	**0**	**20**
No. Of Hrs.				**0**	**0**	**50**	**0**	**--**

VII Semester		
GROUP F: PROFESSIONAL ELECTIVES		
Sl No	**Course Code**	**Course Title**
1.	16CS7F1	Big Data Analytics
2.	16CS7F2	Multimedia Computing
3.	16CS7F3	Fuzzy Graphs, Fuzzy Soft Sets and Petrinets
4.	16CS7F4	Internet of Things
5.	16CS7F5	Application Delivery Controller (Industry Offered)
GROUP G: PROFESSIONAL ELECTIVES		
1.	16CS7G1	An Introduction to Game Theory
2.	16CS7G2	Storage Area Networks
3.	16CS7G3	Software Defined Networks
4.	16CS7G4	Cryptography and Network Security
5.	16CS7G5	Computer Vision

GROUP H: GLOBAL ELECTIVES				
Sl. No.	**Host Dept**	**Course Code**	**Course Title**	**Credits**
1.	BT	16G7H01	Nanotechnology	3
2.	CH	16G7H02	Industrial Safety and Risk Management	3
3.	CV	16G7H03	Intelligent Transport System	3
4.	CS	16G7H04	Intelligent Systems	3
5.	EC	16G7H05	Image Processing and Machine Learning	3
6.	EE	16G7H06	Design of Renewable Energy Systems	3
7.	IM	16G7H07	Systems Engineering	3
8.	EI	16G7H08	MEMS and Applications	3
9.	IS	16G7H09	Introduction to Internet of Things	3
10.	ME	16G7H10	Industry 4.0 – Smart Manufacturing for The Future	3
11.	TE	16G7H11	Space Technology and Applications	3
12.	MA	16G7H12	Advanced linear Algebra	3
13.	PY	16G7H13	Thin Film Nanotechnology	3
14.	CY	16G7H14	Engineering Materials for Advanced Technology	3
15.	HSS	16G7H15	Applied Psychology for Engineers	3
16.	HSS	16G7H16	Foundational Course on Entrepreneurship	3
17.	AS	16G7H17	Unmanned Aerial Vehicles	3

Semester: VII						
PARALLEL ARCHITECTURE & DISTRIBUTED PROGRAMMING (Theory and Practice)						
Course Code	**:**	**16CS71**		**CIE**	**:**	**100+50 Marks**
Credits: L:T:P:S	**:**	**3:0:1:0**		**SEE**	**:**	**100+50 Marks**
Hours	**:**	**33L**		**SEE Duration**	**:**	**3.00 + 3.00 Hours**

Course Learning Objectives:	
1	To review the trends in parallel programming.
2	To demonstrate the basic ideas of multiprocessing and parallel operations with case studies.
3	To expose to basics of parallel programming.
4	To demonstrate parallel programming using MPI, OpenAcc and OpemMP.

Unit-I	**07 Hrs**
Multiprocessors and Thread level parallelism: Introduction, Symmetric shared memory architectures; Performance of symmetric shared-memory multiprocessors, Distributed shared memory and directory-based coherence, Basics of synchronization, Models of memory consistency.	
Unit-II	**07 Hrs**
Data-Level Parallelism in Vector, SIMD, and GPU Architectures: Introduction, Vector Architecture, SIMD Instruction Set Extensions for Multimedia, Graphics Processing Units, Detecting and Enhancing Loop-Level Parallelism, Mobile versus Server GPUs and Tesla versus Core i7.	
Unit-III	**07 Hrs**
Introduction to Parallel Programming: Motivation, Scope of Parallel Computing, Principles of Parallel Algorithm design: Preliminaries, Decomposition Techniques, Characteristics of Tasks and Interactions, Mapping Techniques for Load Balancing, Methods for containing Interaction Overheads, Parallel Algorithms Models.	
Unit-IV	**06 Hrs**
Programming Using the Using Message Passing Paradigm: Principles of Message Passing Programming, Building Blocks, MPI, Topologies and Embedding, Overlapping Communication with computation, Collective Communication and computation operations, Groups and Communicators.	
Unit-V	**06 Hrs**
GPU Programming using OpenACC: Serial to parallel programming using OpenACC: A Simple Data-Parallel Loop, Task-Parallel Example, Amdahl's Law and Scaling, Parallel Execution and Race Conditions, Lock-Free Programming, Controlling Parallel Resources. **Pipelining data transfers with OpenACC:** Introduction to Pipelining, Mandelbrot Generator, Pipelining Across Multiple Devices.	

Laboratory Component
Students are supposed to execute the programs on computationally intensive algorithms like image processing, scientific computing, compression, decompression, encoding, decoding, encryption and decryptions.

Course Outcomes: After completing the course, the students will be able to	
CO1.	Explore the fundamentals of high performance computing concepts.
CO2.	Analyze the performance of parallel programming.
CO3.	Design parallel computing constructs for different applications.
CO4.	Demonstrate Parallel computing concepts for suitable applications.

Reference Books

1.	Introduction to Parallel Computing, Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar, 2nd Edition, 2013, Pearson Education, ISBN 13: 9788131708071.
2.	CUDA Programming: A Developers Guide to Parallel Computing with GPUs, Shane Cook, 1st Edition, 2013, Morgan Kaufmann, ISBN:9780124159334.
3.	Parallel Programming with Open ACC, Rob Farber, 1st Edition, 2016, Morgan Kaufmann(MK) Publication, ISBN :9780124103979.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for assignment is 10. The total marks of CIE are 100.

Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Laboratory- 50 Marks

The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of marks over number of weeks is considered for 40 marks. At the end of the semester a test is conducted for 10 marks. Total marks for the laboratory is 50.

Total CIE is 40(AM) +10 (T) =50 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Laboratory- 50 Marks

Experiment Conduction with proper results is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	-	-	1	1	1	-	-	-	-	-	-	1
CO2	-	2	2	2	2	-	-	-	1	1	-	2
CO3	2	2	2	2	2	1	-	1	1	1	-	2
CO4	2	2	2	2	2	1	1	1	1	1	-	2

High-3 : Medium-2 : Low-1

Semester: VII						
DATA SCIENCE AND MACHINE LEARNING ESSENTIALS (Theory and Practice)						
Course Code	**:**	**16CS72**		**CIE**	**:**	**100+50 Marks**
Credits: L:T:P:S	**:**	**3:0:1:0**		**SEE**	**:**	**100+50 Marks**
Hours	**:**	**36L**		**SEE Duration**	**:**	**3.00 + 3.00 Hours**

Course Learning Objectives:	
1	Have basic knowledge about the key algorithms and theory that form the foundation of machine learning and computational intelligence.
2	Have a practical knowledge of machine learning algorithms and methods so that they will be able to understand the principles, advantages, limitations and possible applications of machine learning.
3	Understand the principles, advantages, limitations and possible applications of machine learning.
4	To identify and apply the appropriate machine learning technique to classification, pattern recognition, optimization and decision problems.
5	Leverage interpersonal dynamics and leadership.

Unit-I	**06 Hrs**
Introduction to Data Science and Machine Learning: Introduction to Data Science and Machine Learning, Examples of Machine Learning Supervised Learning: Learning a class from examples, VC Dimension, PAC learning, Noise, Learning multiple classes, Regression.	
Unit -II	**08 Hrs**
Parametric Methods: Introduction, Maximum Likelihood Estimation, Evaluating an estimator, Bias and Variance, Bayes Estimator, Parametric classification, Regression. **Multivariate Methods:** Multivariate data, Parameter estimation, Estimation of Missing Values, Multivariate normal distribution, Multivariate classification.	
Unit -III	**07 Hrs**
Clustering: Introduction, Mixture densities, K means clustering, EM algorithm, Supervised Learning after clustering, Hierarchical clustering. **Nonparametric Methods**: Introduction, Non parametric Density Estimation, Generalization to Multivariate Data, Nonparametric Classification, Condensed Nearest Neighbour.	
Unit -IV	**07 Hrs**
Linear Discrimination: Introduction, Generalizing the Linear Model, Geometry of linear Discriminant, pair wise Separation, Gradient Descent, Logistic Discrimination, Discrimination by Regression.	
Unit -V	**08 Hrs**
Multilayer Perceptrons: Introduction, The Perceptron, Training a Perceptron ,Learning Boolean Functions, Multilayer Perceptrons, MLP as a universal approximator, Back Propagation algorithm	

Laboratory Component
Laboratory Experiments: 1. Implement the ID3 algorithm for learning Boolean–valued functions for classifying the training examples by searching through the space of a Decision Tree. 2. Design and implement the Back-propagation algorithm by applying it to a learning task involving an application like FACE RECOGNITION. 3. Demonstrate of pre-processing tasks on a given dataset. 4. Demonstrate of Association rule process on a dataset using Apriori algorithm. 5. Demonstrate of classification rule process on a dataset using Naïve Bayes algorithm. 6. Demonstrate of clustering rule process on a dataset using Simple K-means for different values of K.

Indicative Datasets: student.arff, contactlenses.arff, test.arff, employee.arff, iris.arff, mushroom.arff etc

Course Outcomes: After completing the course, the students will be able to	
CO1.	Explore and apply the fundamentals of machine learning techniques.
CO2.	Utilize different mathematical techniques to construct algorithms.
CO3.	Analyze the strength and weakness of different machine learning models to solve real world problems.
CO4.	Implement and apply different supervised and unsupervised machine learning algorithms.

Reference Books	
1.	Practical data science with R, Zumel, N. & Mount, J. 2014, Manning Publications, ISBN 9781617291562
2.	Introduction to Machine Learning, Ethem Alpaydin, 2nd Edition, 2010, PHI Publication, ISBN-978-81-203-4160-9.
3.	Pattern Classification, Richard O. Duda, Peter E. Hart and David G. Stork, 2nd Edition, 2001, Wiley-Inter science, ISBN-13: 978-04710566902001.
4.	Data Mining – Concepts and Techniques, Jiawei Han and Micheline Kamber, 3nd Edition, 2006, Morgan Kaufmann, ISBN 1-55860-901-6.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for assignment is 10. The total marks of CIE are 100.

Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Laboratory- 50 Marks

The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of marks over number of weeks is considered for 40 marks. At the end of the semester a test is conducted for 10 marks. Total marks for the laboratory is 50.

Total CIE is 40(AM) +10 (T) =50 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Laboratory- 50 Marks

Experiment Conduction with proper results is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**2**	**2**	**--**	**--**	**2**	**2**	**2**	**--**	**2**	**2**	**--**	**3**
CO2	**2**	**2**	**2**	**--**	**3**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO3	**--**	**--**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**2**
CO4	**L**	**2**	**--**	**3**	**2**	**2**	**--**	**--**	**2**	**--**	**--**	**2**

High-3 : Medium-2 : Low-1

Semester: VII						
COMPUTER GRAPHICS (Theory & Practice)						
Course Code	**:**	**16CS73**		**CIE**	**:**	**100+50 Marks**
Credits: L:T:P:S	**:**	**3:0:1:0**		**SEE**	**:**	**100+50 Marks**
Hours	**:**	**36L**		**SEE Duration**	**:**	**3.00 + 3.00 Hours**

Course Learning Objectives:	
1	Acquire the basic concepts of 2D and 3D graphics, underlying mathematical aspects and Algorithms such as Line drawing, Circle drawing, Polygon filling, Clipping and Transformations.
2	Understand and explore the concepts of Computer Graphics using industry standard software OpenGL.
3	Design and Implement real time projects using OpenGL.
4	Develop problem solving skills using advanced rendering techniques.

Unit-I	**08 Hrs**
Graphics Systems and Models : *Introduction, Application areas of Computer Graphics, overview of graphics systems, video-display devices, raster-scan systems, random scan systems, graphics monitors and work stations and input devices* **Graphics Programming with OpenGL:** The Sierpinski Gasket, Programming Two-Dimensional Applications, Coordinate Systems, The openGL API: Graphics Functions, The Graphics Pipeline and state Machines, The openGL Interface, Primitives and Attributes, Polygon Basics: polygon types in openGL , Drawing a Sphere Text, Curved Objects, Attributes, Color, RGB Color, Indexed Color, Setting of color Attributes, Viewing, two-dimensional Viewing, The orthographic view, Matrix modes. Control Functions, Interaction with the window system, Aspect Ratio and view ports, Program Structure. The main, display, and myinit Functions, Polygons and Recursion. The Three- Dimensional Gasket. Use of Three-Dimensional points. Input and Interaction:Input Devices. Physical Input Devices, Logical Devices. Measure and trigger. Input Modes. Clients and servers. Display Lists Definition and execution of display Lists, Programming. Event-Driven Input: Using the pointing device, Window events, and Keyboard events. The display and idle callbacks. Window management. Menus.	
Unit -II	**08 Hrs**
Raster graphics algorithms : Points and lines, line drawing algorithms, mid-point circle and ellipse algorithms. Filled area primitives: Scan line polygon fill algorithm, boundary-fill and flood-fill algorithms. 2-D viewing: The viewing pipeline, viewing coordinate reference frame, window to view-port coordinate transformation, viewing functions, Cohen-Sutherland and Cyrus-beck line clipping algorithms, Sutherland –Hodgeman polygon clipping algorithm.	
Unit -III	**07 Hrs**
Geometric Transformations : 2-D geometrical transformations: Translation, Scaling, Rotation, reflection and shear transformations, matrix representations and homogeneous coordinates, composite transforms, transformations between coordinate systems. 3-D Geometric transformations: Translation, rotation, scaling, reflection and shear transformations, composite transformations.	
Unit -IV	**06 Hrs**
Viewing : Viewing pipeline: viewing coordinates, view volume, 3-D clipping. Projections: Classification	

of planar geometric projections, Mathematics of perspective and parallel projections, projection matrices, projections in openGL.

Unit -V	**07 Hrs**

Curves, Surfaces and Visible surface detection :
3-D object representation: Polygon surfaces, Quadratic surfaces, Spline representation. Hermite curve, Bezier curve and B-Spline curves, Bezier and B-Spline surfaces. Visible surface detection: Classification, back-face detection, depth-buffer, scan-line, depth sorting, BSP-tree methods, area sub-division and octree methods.

Laboratory Component

Implement the following programs in C/C++ with OpenGL Libraries:

1. Write a program to generate a line using Bresenham's line drawing technique. Consider slopes greater than one and slopes less than one. User must able to draw as many lines and specify inputs through keyboard/mouse.
2. Write a program to generate a circle and ellipse using Bresenham's circle drawing and ellipse drawing techniques. Use two windows to draw circle in one window and ellipse in the other window. User can specify inputs through keyboard/mouse.
3. Write a program to recursively subdivides a tetrahedron to form 3D Sierpinski gasket. The number of recursive steps is to be specified at execution time.
4. Write a program to fill any given polygon using scan-line area filling algorithm.
5. Write a program to create a house like figure and perform the following operations.
   i. Rotate it about a given fixed point using OpenGL transformation functions.
   ii. Reflect it about an axis y=mx+c using OpenGL transformation functions.
6. Write a program to implement the Cohen-Sutherland line clipping algorithm. Make provision to specify the input for multiple lines, window for clipping and viewport for displaying the clipped image.
7. Write a program to implement the Liang-Barsky line clipping algorithm. Make provision to specify the input for multiple lines, window for clipping and viewport for displaying the clipped image.
8. Write a program to implement the Cohen-Hodgeman polygon clipping algorithm. Make provision to specify the input polygon and window for clipping.
9. Write a program to model a car like figure using display lists and move a car from one end of the screen to other end. User is able to control the speed with mouse.
10. Write a program to create a color cube and spin it using OpenGL transformations.
11. Create a menu with three entries named curves, colors and quit. The entry curves has a sub menu which has four entries namely Limacon, Cardiod, Three-Leaf, and Spiral. The color menu has sub menu with all eight colors of RGB color model. Write program to create the above hierarchical menu and attach appropriate services to each menu entries with mouse buttons.
12. Write a program to construct Bezier curve. Control points are supplied through keyboard/ mouse.

Course Outcomes: After completing the course, the students will be able to	
CO1.	Understand and explore the basic concepts of Computer Graphics which illustrates the use of the pipeline architecture, OpenGL library.
CO2.	Analyze and make an appropriate choice of methods required for computer representation of 2D/3D objects.
CO3.	Design applications like games which involve animation using OpenGL library.
CO4.	Implement common geometric construction techniques as a solution to engineering applications.

Reference Books	
1.	Computer Graphics with OpenGL, Donald D. Hearn, M. Pauline Baker, Warren Carithers,

	4th Edition, 2010, Pearson Education, ISBN-13: 978-0136053583.
2.	Interactive Computer Graphics: A Top-Down Approach Using OpenGL, Edward Angel, 5th Edition, 2010, Pearson Education, ISBN: 978131725306.
3.	Computer Graphics, Zhigang Xiang and Roy Plastock, 2nd Edition, 2007, ASIN: 0070601658, Tata McGraw-Hill, ISBN-13: 978-0070601659.
4.	Computer Graphics Using Open GL, Francis S Hill, Jr., Stephen M Kelley, 3rd Edition, 2007, Pearson Education, ISBN-13: 9780131496705.

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for assignment is 10. The total marks of CIE are 100.
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CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**-**	**1**
CO2	**3**	**3**	**3**	**3**	**1**	**-**	**-**	**-**	**3**	**3**	**-**	**1**
CO3	**3**	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**3**	**-**	**-**	**1**
CO4	**3**	**3**	**3**	**1**	**2**	**-**	**-**	**-**	**3**	**2**	**-**	**1**

High-3 : Medium-2 : Low-1

Semester: VII						
BIG DATA ANALYTICS (Group F : Professional Core Elective)						
Course Code	**:**	**16CS7F1**		**CIE**	**:**	**100 Marks**
Credits: L:T:P:S	**:**	**4:0:0:0**		**SEE**	**:**	**100 Marks**
Hours	**:**	**46L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives:	
1	Learn and know the Big Data flow in different aspects.
2	Select the correct big data stores for disparate data sets
3	Being able to utilize and apply the Data Analytics lifecycle to Big Data analytics projects.
4	Process large data sets using Hadoop to extract value.
5	Query large data sets in near real time with Pig and Hive.

Unit-I	**09 Hrs**
INTRODUCTION TO BIG DATA Issues with Unstructured Data, Characteristics of Data, Evolution of Big Data, Four Vs, Drivers for Big data, Big data analytics, Comparison with Other Systems RDBMS, Grid Computing, A Brief History of Hadoop, Introduction to Apache Hadoop and Hadoop Ecosystem, Terminologies Used in Big Data Environment, In Memory Analytics, In Database Processing, Parallel versus Distributed Systems, Shared Nothing Architecture, Consistency, Availability, Partition Tolerance (CAP): Theorem, Classification of Analytics.	
Unit II	**09 Hrs**
HADOOP ARCHITECTURE Hadoop Architecture, Hadoop Storage: HDFS, Common Hadoop Shell commands, Anatomy of File Write and Read., NameNode, Secondary NameNode, and DataNode, Hadoop MapReduce paradigm, Map and Reduce Programming, Job and Task trackers, MapReduce Example	
Unit -III	**09 Hrs**
HADOOP ECOSYSTEM AND YARN Hadoop ecosystem components - SPARK architecture, FLUME architecture, Hadoop 2.0 New Features- NameNode High Availability, HDFS Federation, MRv2, YARN, Running MRv1 in YARN.	
Unit -IV	**09 Hrs**
HIVE AND PIG Hive Architecture, Comparison with Traditional Database, HiveQL - Querying Data - Sorting And Aggregating, Map Reduce Scripts, Joins & Sub queries, Pig Latin - Structure, Statements, Expressions, Types, Schemas, Functions, Macros, User-Defined Functions	
Unit -V	**10 Hrs**
CASSANDRA BASICS Apache Cassandra – An Introduction, Features of Cassandra, Gossip and Failure Detection, Partitioner, Replication Factor, Anti-Entropy and Read Repair, Writes in Cassandra, Hinted Handoffs, Tunable Consistency: Read Consistency and Write Consistency, CQL Data Types, CQLSH, Keyspaces, CRUD, Insert, Update, Delete, Select, Collections, Set, List, Map, Using a Counter, Time To Live (TTL), Alter: Alter Table to Change the Data Type of a Column, Alter Table to Delete a Column, Drop a Table, Drop a Database, Import and Export, Export to CSV, Import from CSV, Import from STDIN, Export to STDOUT	

Course Outcomes: After completing the course, the students will be able to	
CO1.	Understand and explore the concepts of Big data analytics.
CO2.	Analyze map reduce concepts to solve complex problems.
CO3.	Review and explore the use of different Hadoop Ecosystem components.
CO4.	Apply big data analytics techniques using Hive, PIG, and Cassandra for querying big datasets.

Reference Books	
1.	HADOOP: The definitive Guide ,Tom White, , 4th Edition, O Reilly, 2015, ISBN: 978-144936107
2.	Big Data and Analytics ,Seema Acharya and Subhashini C, , 1st Edition Wiley India Private Limited, 2015, ISBN 978-8126554782..
3.	Big Data Analytics: Turning Big Data into Big Money ,Frank J Ohlhorst, , Wiley and SAS Business Series, 2012 Edition , ISBN: 978-1118147597.
4.	Mining of Massive Datasets, Anand Rajaraman and Jeffrey David Ullman, 2nd Edition, Cambridge University,Press, 2017, ISBN-13: 978-1107015357.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for assignment is 10. The total marks of CIE are 100.

Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**-**	**1**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**3**
CO2	**1**	**3**	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**1**
CO3	**-**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**
CO4	**2**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**2**

High-3 : Medium-2 : Low-1

Semester VII						
MULTIMEDIA COMPUTING (Group F : Professional Core Elective)						
Course Code	**:**	**16CS7F2**		**CIE**	**:**	**100 Marks**
Credits: L:T:P:S	**:**	**4:0:0:0**		**SEE**	**:**	**100 Marks**
Hours	**:**	**44L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives:	
1	Explore the various Multimedia features, its representation and computing techniques.
2	Gain knowledge of video signal representation and its transmission for conventional and high definition television.
3	Acquire knowledge of various compression techniques for text, audio and video.
4	Investigate various formats and protocols related to multimedia network communication.

Unit-I	**10 Hrs**
Multimedia Communications: Introduction, Multimedia information representation, Multimedia networks, Telephone networks, Data networks, Broad cast television networks, Integrate services digital networks, Broad multiservice networks, Multimedia applications, Inter personal communication, Interactive applications over the internet, Entertainment applications, Application and Networking terminology, Media types, communication modes, network types, Multi point conferencing, Network QoS, Application QoS.	
Unit -II	**09 Hrs**
Multimedia information representation: Introduction, Digitization principles, Analog signals, Encoder design, Decoder Design, Audio, PCM speech, CD- quality audio, synthesized audio, Video, Broad cast Television, Digital Video, PC video, Video content.	
Unit -III	**08 Hrs**
Text and image compression: Introduction, Compression principles, Source encoder and destination decoder, Lossless and Lossy compression, entropy encoding, source encoding, Text compression, Static Huffman coding, Dynamic Huffman coding, Arithmetic coding, Lempel-Ziv coding, Lempel-Ziv-Welsh coding, Image compression, Graphic Interchange Format, Tagged Image File , Digitized Documents, Digitized pictures, JPEG.	
Unit -IV	**08 Hrs**
Audio compression : Introduction, Audio compression Differential Pulse code modulation, Adaptive differential PCM, Adaptive Predictive coding, Linear Predictive coding, Code-exited LPC, Perceptual coding, MPEG audio coders, Dolby audio coders.	
Unit -V	**09 Hrs**
Video compression : Video compression, Video compression principles, H.261, H.263, MPEG, MPEG-1, MPEG-3, MPEG-4. **Case Study :** Digital Broadcast, Internet Streaming, Open source Multimedia tools such as FFMPEG, VLC.	

Course Outcomes: After completing the course, the students will be able to	
CO1.	Acquire knowledge and explore various terminologies related to network communications of multimedia data.
CO2.	Investigate the characteristics of different media types and its representation, various data formats for image, video and audio system.
CO3.	Apply various types of image, audio, video representation formats and compression techniques for multimedia data.
CO4.	Analyze appropriate formats and protocols for representing multimedia information for Internet based applications

Reference Books	
1.	Multimedia Communications: Applications, Networks, Protocols and Standards, Fred Halsall, 4th Edition, 2016, Pearson Publications, ISBN: 978-81-317-0184-3.
2.	Fundamentals of Multimedia, Ze-Nian Li and Mark S. Drew, 2nd Edition, 2014, Springer International Publishing, ISBN: 9783319052892.
3.	Multimedia: Computing, Communication and Applications, Ralf Steinmetz and Klara Nahrstedt, 1st Edition, 2014, Pearson Education, ISBN 978-81-775-8441-7.
4.	Techniques & Standards for Image, Video & Audio Coding, Rao K R & Hwang J J, 1st Edition, 2001, PTR-PH Publishers, *ISBN*-13: 978-3540239574.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for assignment is 10. The total marks of CIE are 100.

Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**1**	**1**	**-**	**-**	**-**	**1**	**1**	**-**	**-**	**-**	**-**	**3**
CO2	**2**	**2**	**-**	**1**	**1**	**-**	**-**	**-**	**-**	**1**	**-**	**2**
CO3	**1**	**3**	**1**	**-**	**-**	**-**	**-**	**2**	**1**	**1**	**-**	**2**
CO4	**2**	**1**	**-**	**-**	**1**	**-**	**-**	**2**	**2**	**-**	**-**	**2**

High-3 : Medium-2 : Low-1

Semester VII						
FUZZY GRAPHS, FUZZY SOFT SETS AND PETRINETS (Group F : Professional Core Elective)						
Course Code	**:**	**16CS7F3**		**CIE**	**:**	**100 Marks**
Credits: L:T:P:S	**:**	**4:0:0:0**		**SEE**	**:**	**100 Marks**
Hours	**:**	**44L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives:	
1	Learn basic skills of Fuzzy Graph Theory, Fuzzy sets, Fuzzy graphs in Database theory, Fuzzy Decision trees, Network Models using fuzzy graphs.
2	Analyze constructing the fuzzy graphs which gives the student a good insight into various topics like Trees, level cut, chords, eccentricity.
3	Know the Knowledge of different forms of fuzzy graphs, interval-valued fuzzy graphs and intuitionistic fuzzy graphs and gross characteristics.
4	Investigate otherforms offuzzy graphs like petrinets.

UNIT-I	**10 Hrs**
Introduction to Fuzzy Graphs: Fuzzy graphs- partial fuzzy sub graphs, fuzzy sub graphs, weak isomorphism,co-weak isomorphism, isomorphism of fuzzy graphs , complement of a fuzzy graph, regular fuzzy graph and edge regular fuzzy graphs.Connectivity in Fuzzy Graphs: Path and connectedness, Connectivity in fuzzy graphs, Strong arcs, Bridges and cut vertices, Trees, Maximal Spanning tree, Fuzzy Spanning tree and cycles, Connectedness level, cut sets, fuzzy chords, fuzzy co trees, fuzzy Twigs.	
UNIT-II	**9 Hrs**
Operations and characterization in fuzzy graphs: Operations on fuzzy graphs: union, intersection, join, Cartesian product and composition, fuzzy line graphs, Fuzzy interval graphs, Edge connectivity, vertex connectivity, Eccentricity of fuzzy graph and density of fuzzy graph. The Fulkerson and gross characterization and The Gilmore and Gross characterization theorems.	
UNIT-III	**8 Hrs**
Applications of Fuzzy Graphs: Fuzzy node connectivity, Fuzzy arc connectivity, Cluster, cluster analysis, application to cluster analysis, fuzzy intersection equations, intuitionistic fuzzy graph and properties of intuitionistic fuzzy graphs, Interval valued fuzzy graphs, Fuzzy graphs in Database theory**,** Fuzzy Decision trees, Network Models using fuzzy graphs.	
UNIT-IV	**9 Hrs**
Theory of Fuzzy Soft Sets: Soft Sets and Fuzzy Soft Sets – Soft sets and Fuzzy Soft set operations, Properties of soft sets and Fuzzy Soft Sets, Cartesian product of soft sets and fuzzy soft sets, Fuzzy Soft set Relations, Operations on Fuzzy Soft Set Relations, Properties of Fuzzy Soft set Relations and Composition of fuzzy Soft Set relation.	
UNIT-V	**08 Hrs**
Petrinets: Petri Nets, Petri Nets for Rule – Based Decision making, Introduction to Petrinets, firing rule, firing sequences and reachability, Behavioural properties of petrinets, Analysis methods, Co-variability tree, reachability graph , Simple reduction rules, Characteristics of liveness and structural properties.	

Course Outcomes: After completing the course, the students will be able to	
CO1.	Understand and explore the of concepts like fuzzy graph, connectivity,operations and Petrinets.
CO2.	Demonstrate and analyze applications of various methodologies like cluster analysis and its applications by annualizing problems such as neural networks database theory, Petrinets.
CO3.	Apply fuzzy graph theory skills as applicable to engineering discipline.
CO4.	Solve real world problem involving emerging technologies andmulti-disciplinary tasks.

Reference Books	
1.	Fuzzy graphs, Basics Concepts and Applications, S Mathew and M S Sunitha, 2012, Lambert Academic Publishing ,ISBN:978-3-659-21234-5.
2.	Application to Petrinets-Thesis submitted by Bucket YILMAZ for degree of Master of Science-2008.
3.	Fuzzy Graphs and Fuzzy Hypergraphs, J. N. Mordeson and P.S. Nair, Physica- Verlag, 2000, ISBN:3-7908-1286-2.
4.	Fuzzy Discrete Structures, D.S. Malik and J.N. Mordeson, Physica – Verlag , 2000, ISBN:3790813257.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

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Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**1**	**1**	**-**	**2**	**2**	**1**	**-**	**1**	**-**	**-**	**-**	**1**
CO2	**1**	**3**	**-**	**2**	**2**	**1**	**-**	**1**	**1**	**2**	**2**	**1**
CO3	**2**	**1**	**-**	**1**	**1**	**1**	**-**	**1**	**1**	**2**	**1**	**2**
CO4	**2**	**2**	**2**	**2**	**1**	**1**	**1**	**-**	**1**	**1**	**2**	**-**

High-3 : Medium-2 : Low-1

Semester VII						
INTERNET OF THINGS (Group F : Professional Core Elective)						
Course Code	**:**	**16CS7F4**		**CIE**	**:**	**100 Marks**
Credits: L:T:P:S	**:**	**4:0:0:0**		**SEE**	**:**	**100 Marks**
Hours	**:**	**44L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to	
1	Develop a fundamental understanding on IOT technology.
2	Understand and visualize the components of the methodology.
3	Analyze the contemporary advances and innovation in various fields of IOT technology.
4	Study and implement converging technologies like 6LoWPAN, IPV6 that is emerging in the domain.

UNIT-I	**08Hrs**
The Internet of Things Overview and Motivations, Examples of Applications, IPV6 Role, Areas of Development and Standardization, Scope of the Present Investigation. Internet of Things Definitions and frameworks-IoT Definitions, IoT Frameworks, Basic Nodal Capabilities. Internet of Things Application Examples-Overview, Smart Metering/Advanced Metering Infrastructure-Health/Body Area Networks, City Automation, Automotive Applications, Home Automation, Smart Cards, Tracking.	
UNIT-II	**09 Hrs**
Fundamental IoT Mechanism and Key Technologies Identification of IoT Object and Services, Structural Aspects of the IoT, Key IoT Technologies. Evolving IoT Standards-Overview and Approaches, IETF IPV6 Routing Protocol for RPL Roll, Constrained Application Protocol (COAP), Representational State Transfer (REST), ETSI M2M, Third Generation Partnership Project Service Requirements for Machine-Type Communications, CENELEC, IETF IPv6 Over Low power WPAN, Zigbee IP (ZIP), IPSO.	
UNIT-III	**09 Hrs**
Layer ½ Connectivity: Wireless Technologies for the IoTWPAN Technologies for IoT/M2M, Zigbee/IEEE 802.15.4, Bluetooth and its Low-Energy Profile, IEEE 802.15.6 WBANs, Dedicated Short-Range Communications (DSRC) and Related Protocols. **Cellular and Mobile Network Technologies** for IoT/M2M, Overview and Motivations, Universal Mobile Telecommunications System, LTE.	
UNIT-IV	**09 Hrs**
Layer 3 Connectivity:IPv6 Technologies for the IoT: Overview and Motivations. Address Capabilities,IPv6 Protocol Overview, IPv6 Tunnelling, IPSec in IPv6, Header Compression Schemes, Quality of Service in IPv6, Migration Strategies to IPv6.Embedding, Overlapping Communication with computation, Collective Communication and computation operations, Groups and Communicators.	
UNIT-V	**09Hrs**
The Wireless Embedded Internet: Why6LoWPAN? Relation of 6LoWPAN to other trends, Applications of 6LoWPAN, Example: Facility management, The 6LoWPAN Architecture. 6LoWPAN Introduction, The protocol stack. Link layers for 6LoWPAN, Addressing, Header format, Bootstrapping, Mesh topologies, Internet integration.	
The 6LoWPAN Format: Functions of an Adaptation Layer, Assumptions About the Link Layer, The Basic 6LoWPANFormat, Addressing, Forwarding and Routing, Header Compression, Fragmentation and Reassembly, Multicast.	

Course Outcomes: After completing the course, the students will be able to	
CO1.	To understand and explore the basic need for IOT ,6LOWPAN and its building blocks
CO2.	Analyze the protocols used in designing IOT applications.
CO3.	Exploring how IOT, cellular and Mobile networks can work together
CO4.	Synthesis IOT based applications using language support.

Reference Books	
1.	Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications, 2013, .Daniel MinoliWiley, ISBN: 978-1-118-47347-4.
2.	Internet of Things : A Hands on Approach, Arshdeep Bahga, Vijay Madisetti, 2015, Universities Press, ISBN, : 978-81-7371-954-7.
3.	The Internet of Things, Michael Miller, First Edition, 2015, Pearson.
4.	6LoWPAN: The Wireless Embedded Internet, Zach Shelby, Carsten Bormann, December 2009,ISBN: 978-0-470-74799-5.

Continuous Internal Evaluation (CIE); Theory (100 Marks)
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Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)
SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**2**	**2**	**1**	**1**	**-**	**-**	**-**	**2**	**2**	**2**	**-**	**1**
CO2	**2**	**3**	**1**	**3**	**-**	**-**	**-**	**1**	**1**	**1**	**-**	**1**
CO3	**2**	**2**	**1**	**1**	**-**	**-**	**-**	**1**	**2**	**2**	**-**	**1**
CO4	**2**	**3**	**1**	**1**	**-**	**2**	**2**	**1**	**1**	**1**	**-**	**1**

High-3 : Medium-2 : Low-1

Semester VII						
APPLICATION DELIVERY CONTROLLER (Industry Offered) **(Group F : Professional Core Elective)**						
Course Code	**:**	**16CS7F5**		**CIE**	**:**	**100 Marks**
Credits: L:T:P:S	**:**	**4:0:0:0**		**SEE**	**:**	**100 Marks**
Hours	**:**	**44L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives:	
1	Understand the functionalities of various network functions.
2	Analyze the design issues involved in load balancers, traffic management.
3	Introduce students the concept of Application delivery controller.
4	Illustrate the operation of cloud and virtualization.

Unit-I	**08 Hrs**
SSL details, SSL offloading, Deployment models for Enterprise Apps, Deep Packet Inspection, Web Application Firewalls (WAF), Intrusion prevention system (IPS), Difference Between an IPS and WAF, Deployment modes for NSX.	
Unit -II	**09 Hrs**
Load balancers: Concepts of L4 load balancing, Managing application delivery using load balancers, L7 Load balancing, persistence methods, health monitoring **ADC**: Introduction, Why ADC is needed and a brief introduction, How ADC is different from a legacy load balancer, Overview of broadened ADC use cases	
Unit -III	**09 Hrs**
Traffic Management: Core principles of traffic management, Multiprotocol Label Switching, SSL offloading and acceleration, DNS and global server load balancing, Introduction to Optimization and Security.	
Unit -IV	**09 Hrs**
Virtualization and Cloud : Essentials of virtualization and cloud computing, Cloud computing infrastructure**,** Mobile Cloud computing**,** Why virtualizing ADCs is important, How to deliver Apps through Cloud and virtual data centers	
Unit -V	**09 Hrs**
Software Defined Networking (SDN) and ADC: Overview of OpenFlow Interfaces- northbound and southbound, SDN APIs, SDN switches, Network Functions Virtualization (NFV), Key SDN fabrics and solutions in industry, How ADC fits into the SDN solutions	

Course Outcomes: After completing the course, the students will be able to	
CO1.	Understand and explore the importance of various network functionalities like load balancer, offloading, firewalls.
CO2.	Identify the components of application delivery controller and its importance.
CO3.	Analyze the operation of internetwork and solve problems related to network traffic management.
CO4.	Investigate the relevance of virtualization and cloud in the present business scenario.

Reference Books	
	Course contents will be provided to students by the instructor.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of

the marks scored from three tests is reduced to 60. The marks component for assignment is 10. The total marks of CIE are 100.
Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)
SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**2**	**3**	**-**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO2	**3**	**2**	**-**	**2**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**
CO3	**2**	**2**	**3**	**-**	**2**	**2**	**1**	**-**	**2**	**-**	**1**	**2**
CO4	**2**	**2**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**1**	**-**

High-3 : Medium-2 : Low-1

Semester VII					
AN INTRODUCTION TO GAME THEORY (Group G : Professional Core Elective)					
Course Code	**:**	**16CS7G1**	**CIE**	**:**	**100 Marks**
Credits: L:T:P:S	**:**	**4:0:0:0**	**SEE**	**:**	**100 Marks**
Hours	**:**	**45L**	**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives:	
1	Comprehend the basics of strategic gaming and mixed strategic equilibrium.
2	Enable students to develop skills on extensive gaming strategies.
3	Analyze and discuss various gaming models.
4	Illustrate some real time situations.

Unit-I	**08 Hrs**
Introduction, Strategic Games: What is game theory?, The theory of rational choice,Interacting decision makers, Strategic games;Examples: The prisoner's dilemma, Bach or Stravinsky, Matching pennies; Nash equilibrium; Examples of Nash equilibrium; Best response functions; Dominated actions;Counot's model of oligopoly, Electoral comprtition.	
Unit -II	**09 Hrs**
Strategic Games: Equilibrium in a single population: symmetric games and symmetric equilibria. **Mixed Strategy Equilibrium:**Introduction; Strategic games in which players may randomize;Mixed strategy Nash equilibrium; Dominated actions;Pureequilibria when randomization is allowed, Illustration: Expert Diagnosis; Equilibrium in a single population, Illustration: Reporting a crime; The formation of players' beliefs; Extensions; Representing preferences by expected payoffs.	
Unit III	**09 Hrs**
Extensive Games: Extensive games with perfect information; Strategies and outcomes;Nash equilibrium; Subgame perfect equilibrium;Finding subgame perfect equilibria of finite horizon games: Backward induction.Illustrations: The ultimatum game, Stackelberg's model of duopoly, Buying votes.	
Unit -IV	**10 Hrs**
Bayesian Games, Extensive Games with Imperfect Information: Motivational examples;General definitions; Two examples concerning information;Illustrations: Cournot's duopoly game with imperfect information, Providing a public good Auctions;Auctions with an arbitrary distribution of valuations,Extensive games with imperfect information; Strategies,	
Unit -V	**09 Hrs**
Competitive,Iterated and Coalitional Games: Strictly Competitive Games, Evolutionary Equilibrium: Strictly competitive games and maximization; Case Study.Repeated games: The main idea; Preferences; Repeated games; Finitely and infinitely repeated Prisoner's dilemma; Strategies in an infinitely repeated Prisoner's dilemma;Nash equilibria of an infinitely repeated Prisoner's dilemma, Nash equilibrium payoffs of aninfinitely repeated Prisoner's dilemma. Coalitional Games and Bargaining: Coalitionalgames, Case Study.	

Course Outcomes: After completing the course, the students will be able to	
CO1.	Interpret the basics of strategic gaming and extensive games.
CO2.	Analyze gaming strategies on real-time incidence.
CO3.	Designing models of gaming on real-time incidence.
CO4.	Application of game theory in Economics, Political Science and corporate world.

Reference Books	
1.	An Introduction to Game Theory, Martin Osborne, Oxford University Press, 1st Indian Edition, 2009, Seventh impression, ISBN – 0195128958.
2.	Analysis of Conflict Game Theory, Roger B. Myerson, Re-print Edition, 2008, Harvard University Press, ISBN – 978-0674341166.
3.	Introduction to Operations Research: Concepts and Cases, Frederick S. Hillier and Gerald J. Lieberman, 9th Edition; 2010, Tata McGraw Hill, ISBN – 0073376299.
4.	An Introduction to Game Theory, Joel Watson; Strategy, 2nd Edition, 2007, W.W. Norton &Company, ISBN – 9780393929348.

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for assignment is 10. The total marks of CIE are 100.
Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)
SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**-**	**1**	**1**	**1**	**-**	**1**	**-**	**2**	**-**	**-**	**-**	**2**
CO2	**2**	**1**	**2**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**2**	**2**
CO3	**-**	**2**	**1**	**2**		**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO4	**1**	**2**	**2**	**1**	**1**	**2**	**2**	**-**	**2**	**2**	**-**	**2**

High-3 : Medium-2 : Low-1

Semester VII						
STORAGE AREA NETWORKS (Group G : Professional Core Elective)						
Course Code	**:**	**16CS7G2**		**CIE**	**:**	**100 Marks**
Credits: L:T:P:S	**:**	**4:0:0:0**		**SEE**	**:**	**100 Marks**
Hours	**:**	**44L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to	
1	Understand storage architectures and key data center elements in classic, virtualized and cloud environments.
2	Understand storage networking technologies such as FC SAN, NAS.
3	Visualize storage virtualization functions in typical data center environment.
4	Articulate business continuity solutions such as backup , replication and archive for managing fixed content.

UNIT-I	**08 Hrs**
INTRODUCTION Introduction to information storage: Information storage, Evolution of storage architecture, Data center infrastructure, Virtualization and Cloud Computing. Data Protection RAID: Implementation methods, RAID array components, RAID techniques, RAID levels, RAID impact on disk performance, RAID comparison, Hot Spares.	
UNIT-II	**10 Hrs**
I/O Techniques The Physical I/O path from CPU to storage system, SCSI, Fiber Channel Protocol Stack, Fiber Channel SAN, IP Storage. **File System and NAS** Local File Systems, Network file Systems and file servers, Shared Disk file systems, Comparison: Fibre Channel SAN, FCoE SAN, iSCSI SAN and NAS. **Network Attached Storage** The NAS Architecture, The NAS hardware Architecture, The NAS Software Architecture, Network connectivity, NAS as a storage system.	
UNIT-III	**10 Hrs**
Storage Virtualization Virtualization in the I/O Path, Limitations and requirements, Definition of storage virtualization, Implementation Considerations, Storagevirtualization on Block or file level, Storage virtualization on various levels of the storage Network, Symmetric and Asymmetric storage virtualization in the Network. **Object based and unified storage** Object based storage devices, content addressed storage, CAS Use Cases, Unified storage.	
UNIT-IV	**08 Hrs**
SANArchitecture and Hardware Devices Overview, creating a Network for storage, SAN Hardware devices, the fiber channel switch, Host Bus adapters, Putting the storage in SAN, Fabric operation from a Hardware perspective. **Software Components of SAN** The switch's operating system, Device Drivers, The Supporting the switch's components,	
UNIT-V	**08 Hrs**
Backup and Recovery Backup purpose, backup consideration, granularity, considerations, methods, process, restore operations, backup technologies, Local Replication: source and target, uses of local replicas, data consistency, local replication technologies, modes of remote replication, remote replication technologies. *Unified storage cluster: CEPH, Case Study: Reliable Autonomic Distributed Object Store (RADOS).	

Course Outcomes: After completing the course, the students will be able to	
CO1.	Explore fundamentals of storage centric paradigm for large Data Centre.
CO2.	Analyze techniques used for data access and maintenance using different evolving technologies in SAN and NAS.
CO3.	Realize storage virtualization on different levels and backup/recovery processes.
CO4.	Evaluate various techniques used in intelligent storage systems.

Reference Books	
1.	Information storage and management- Somasundaram, Gnanasundaram, AlokShrivatsava, 2nd Edition, 2015, Wiley publishing ISBN 978-81-265-3750-1.
2.	Storage Networks Explained – Ulf Troppens, Rainer Erkens and Wolfgang Muller, 2012, John Wiley & Sons, ISBN: 978-81-265-1832-6.
3.	Storage Networks: The Complete Reference – Robert Spalding, 2003, Tata McGraw Hill, ISBN: 978-007224764.
4.	* Latest research papers, white papers, manuals to be referred

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for assignment is 10. The total marks of CIE are 100.

Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**2**	**-**	**3**	**-**	**2**	**-**	**-**	**-**	**1**	**2**	**-**	**1**
CO2	**-**	**2**	**1**	**-**	**2**	**-**	**-**	**-**	**1**	**-**	**-**	**-**
CO3	**2**	**1**	**2**	**2**	**3**	**-**	**-**	**-**	**2**	**1**	**-**	**1**
CO4	**-**	**2**	**-**	**2**	**2**	**-**	**-**	**-**		**-**	**-**	**-**

High-3 : Medium-2 : Low-1

Semester VII						
SOFTWARE DEFINED NETWORKS (Group G : Professional Core Elective)						
Course Code	**:**	**16CS7G3**		**CIE**	**:**	**100 Marks**
Credits: L:T:P:S	**:**	**4:0:0:0**		**SEE**	**:**	**100 Marks**
Hours	**:**	**44L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives:	
1	Explore the emerging definitions, protocols, and standards for SDN.
2	Understand the different use cases of SDN.
3	Understand the role of Hypervisor based overlays and different APIs in designing SDN.
4	Understand the types of applications and future of SDN.

Unit-I	**09 Hrs**
Introduction: The Modern Data Center, Traditional Switch Architecture, Autonomous and Dynamic Forwarding Tables, Increasing the Packet-Forwarding IQ, Open Source and Technological Shifts. **Concepts of SDN:** Evolution of Switches and Control Planes, Cost, SDN Implications for Research and Innovation, Data Center Innovation, Data Center Needs	
Unit -II	**09 Hrs**
Genesis of SDN: The Evolution of Networking Technology, Forerunners of SDN, Software. Defined Networking is Born, Sustaining SDN Interoperability, Legacy Mechanisms Evolve Toward SDN, Network Virtualization.	
Unit -III	**09 Hrs**
OpenFlow Specification - OpenFlow Overview, OpenFlow 1.0 and OpenFlow Basics. **Alternative Definitions of SDN** - Potential Drawbacks of Open SDN, SDN via APIs, SDN via Hypervisor-Based Overlays, SDN via Opening Up the Device, Network Functions Virtualization, Alternatives Overlap and Ranking.	
Unit -IV	**09 Hrs**
SDN in the Data Center- Data Center Definition, Data Center Demands, Tunneling Technologies for the Data Center, Path Technologies in the Data Center, Ethernet Fabrics in the Data Center, SDN Use Cases in the Data Center, Open SDN versus Overlays in the Data Center, Real-World Data Center Implementations. **SDN in Other Environments** - Consistent Policy Configuration, Global Network View, Wide Area Networks, Service Provider and Carrier Networks, Campus Networks, Hospitality Networks, Mobile Networks, In-Line Network Functions, Optical Networks, SDN vs. P2P/Overlay Networks.	
Unit -V	**08 Hrs**
SDN Applications- Reactive versus Proactive Applications, Reactive SDN Applications, Proactive SDN Applications, Analyzing Simple SDN Applications **SDN Futures** - Potential Novel Applications of Open SDN, Applying Programming Techniques to Networks, Security Applications, Hiding IP Addresses, Segregating IPSec Traffic in Mobile Networks, SDN-Enabled Switching Chips	

Course Outcomes: After completing the course, the students will be able to	
CO1.	Understand and explore the basic characteristics of SDN
CO2.	Analyze the working of SDN
CO3.	Examine the design of SDN through APIs and Hypervisor based overlays
CO4.	Identify various SDN applications and environments that benefits from its use

Reference Books	
1.	Software Defined Networks A Comprehensive Approach, Paul Goransson, Chuck Black: Morgan Kaufmann, 2014, ISBN-10: 012416675X, ISBN-13: 978-0124166752.
2.	Software Defined Networks, Thomas D.Nadeau & Ken Gray: SDN O'Reilly publishers, 1st Edition, 2013, ISBN-10: 1449342302, ISBN-13: 978-1449342302.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for assignment is 10. The total marks of CIE are 100.

Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**1**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO2	**1**	**-**	**-**	**2**	**-**	**-**	**1**	**-**	**2**	**2**	**-**	**2**
CO3	**1**	**-**	**-**	**2**	**-**	**-**	**2**	**1**	**2**	**2**	**-**	**2**
CO4	**1**	**-**	**-**	**2**	**-**	**-**	**2**	**1**	**2**	**2**	**-**	**3**

High-3 : Medium-2 : Low-1

Semester VII						
CRYPTOGRAPHY AND NETWORK SECURITY (Group G : Professional Core Elective)						
Course Code	**:**	**16CS7G4**		**CIE**	**:**	**100 Marks**
Credits: L:T:P:S	**:**	**4:0:0:0**		**SEE**	**:**	**100 Marks**
Hours	**:**	**46L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives:	
1	Encrypt and decrypt messages using traditional and modern symmetric ciphers.
2	Analyze existing authentication and key agreement protocols.
3	Identify cryptographic hash functions and message authentication codes.
4	Investigate wired and wireless security policies and protocols for network security.

Unit-I	**08 Hrs**
Traditional Symmetric-Key Ciphers: Introduction, Substitution Ciphers, Transpositional Ciphers, Stream and Block Ciphers. **Data Encryption Standard (DES):** Introduction, DES Structure, DES Analysis, Security of DES. **Advanced Encryption Standard:** Introduction, Transformations, Key Expansion, The AES Ciphers, Examples, Analysis of AES.	
Unit -II	**09 Hrs**
Encipherment using Modern Symmetric-Key Ciphers: Use of Modern Block Ciphers, Use of Stream Ciphers. **Asymmetric Key Cryptography:** Introduction, RSA Cryptosystem. Other public key- cryptosystems: Diffie-Hellman key exchange, Elgamal Cryptosystem.	
Unit -III	**10 Hrs**
Cryptographic Hash functions: Applications of cryptographic hash functions, Tow simple hash functions, Requirements and security, Hash functions based on cipher block chaining, SHA, SHA-3. **Message authentication:** Authentication Requirements, Authentication Functions, Message Authentication Codes, MD5.	
Unit -IV	**09 Hrs**
Digital signatures: Digital Signatures, Digital Signature Algorithm. **Key management and distribution:** Distribution of public keys, X.509 certificates, Kerberos. **Transport level security:** Web Security considerations, Secure Sockets Layer. **IP Security:** IP Security overview, IP Security policy, Encapsulating Security payload.	
Unit -V	**10 Hrs**
Wireless Network Security: IEEE 802.11 Wireless LAN Overview, IEEE 802.11i Wireless LAN Security, Wireless Application Protocol Overview, Wireless Transport Layer Security, WAP End-to-End Security. **Case Study: CrypTool, Delta, Medusa, Metasploit.**	

Course Outcomes: After completing the course, the students will be able to	
CO1.	Understand and Explore symmetric and Asymmetric key ciphers and encipherment modes for encryption/decryption.
CO2.	Identify wired/wireless network security policies and protocols to provide secure data transmission.
CO3.	Apply hash functions and message authentication techniques for user authentication.
CO4.	Analyse digital signature and key distribution mechanisms for secure key exchange for authentication.

Reference Books	
1.	Cryptography and Network Security; William Stallings, 6th Edition, 2015, Pearson Education; ISBN13: 9780273793359.
2.	Cryptography and Network Security, Behrouz A. Forouzan, Debdeep Mukhopadhyay, 2nd Edition, 2010, McGraw-Hill, ISBN: 007070208x.
3.	Cryptography Theory and Practice, Douglas Stinson, 3rd Edition, 2005, Chapman & Hall, ISBN 9781584885085.
4.	Fundamentals of Computer Security, Josef Pieprzyk, Thomas Hardjono, Jennifer Serberry, Springer ISBN: 9783642077135, ISBN: 9783662073247 (eBook), 2009.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for assignment is 10. The total marks of CIE are 100.

Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**2**	**2**	**1**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**1**
CO2	**1**	**1**	**1**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO3	**1**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO4	**1**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**1**	**2**	**-**	**3**

High-3 : Medium-2 : Low-1

Semester VII						
COMPUTER VISION (Group G: Professional Core Elective)						
Course Code	**:**	**16CS7G5**		**CIE**	**:**	**100 Marks**
Credits: L:T:P:S	**:**	**4:0:0:0**		**SEE**	**:**	**100 Marks**
Hours	**:**	**44L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives:	
1	Acquire knowledge on problem solving skills in computer vision.
2	Select appropriate techniques or methods for Filtering, Segmenting, Recognition and classification.
3	Describe basic feature and applications of computer vision in real time applications.
4	Develop skills to work or carry out task on multi-disciplinary domains / projects.

Unit-I	**09 Hrs**
Introduction to Digital Image Fundamentals The origin of Digital Image processing, Fundamental Steps in Digital Image Processing, Components of an Image Processing System, Image Sampling and Quantization, Some Basic Relationships between Pixels.	
Unit -II	**09 Hrs**
Intensity Transformation and spatial Filters: Background, Some basic Intensity Transformation Functions, Histogram Processing, Histogram Equalization, Mechanics of spatial filtering, spatial correlation and convolution, Smoothing spatial filters. **Early vision:** Just one image: Linear Filters, Linear Filters and Convolution, Shift Invariant Linear System, Discrete Convolution, Continuous Convolution., Edge Effects in Discrete Convolution, Spatial Frequency and Fourier Transformation, Fourier Transformation, Sampling and Aliasing, Filters as Templates, Technique: Normalized correlation and Finding Patterns, Technique: Scale and Image Pyramids. **Practical application of filters on images using any open source**	
Unit -III	**09 Hrs**
Image Segmentation Fundamentals, Point, Line Edge detection, Detection of Isolation points, Line detection, Edge Models , basic Edge detection, More Advanced Techniques for Edge Detection , Edge Linking and Boundary Detection, Thresholding : Foundation, Basic global thresholding, Region growing, Region splitting and Merging, segmentation using morphological Watersheds, Background, Dam construction, watershed segmentation algorithm, Use of motions in segmentation. **Demonstration of segmentation on images using any open source**	
Unit -IV	**09 Hrs**
Image Segmentation by using Clustering pixels K-means, Mean shift: Finding Local modes in Data, clustering and segmentation with Mean shift. **Detecting Objects in images** The sliding window method, Face detection, Detecting Humans, Detecting Boundaries, Detecting deformable objects. **Demonstrating detection of objects in images using any open source**	
Unit -V	**08 Hrs**
Topics in Object Recognition Object recognition current strategies of object recognition, categorization , Selection, improving current Image features, other kinds of Image Features, Geometrical , Semantic Questions, Attributes and unfamiliar, parts poselets and consistency, chunks of meanings ,Hand Gesture recognition. **Demonstration of recognition using any open source.**	

Course Outcomes: After completing the course, the students will be able to	
CO1.	Explore and acquire knowledge on fundamentals of computer vision concepts.
CO2.	Analyze the inherent difficulties encountered in computer vision and its interpretation.
CO3.	Apply computer vision techniques to solve complex problems.
CO4.	Investigate and draw inferences by processing image in real time applications.

Reference Books	
1.	Digital Image Processing, Rafael C. Gonzalez, Richard E. Woods, 3rd Edition; 2012, Pearson Education, ISBN- 9780131687288.
2.	Computer Vision: A Modern Approach, David Forsyth and Jean Ponce, 2nd edition, 2015, Prentice Hall, ISBN- 978-81-203-5060-1.
3.	Open CV Computer Vision with Python, Joseph Hawse, Illustrated, 2013, Packt Publishing, ISBN 1782163921, 9781782163923.
4.	Computer Vision: Algorithms and Applications, Richard Szeliski, Springer Verlag, 2013 Edition, ISBN-13: 978-1848829343, ebook :http://szeliski.org/Book/.
5.	Hand Gesture Recognition Using Micro-Doppler Signatures With Convolutional Neural Network, Youngwook kim,, Brian toomajian, IEEE Access, Volume 4, 2016, pages 7125-7130.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for assignment is 10. The total marks of CIE are 100.

Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**-**	**1**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**1**
CO2	**-**	**2**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO3	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO4	**2**	**1**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**

High-3 : Medium-2 : Low-1

Semester: IV						
NANOTECHNOLOGY (Group H: Global Elective)						
Course Code	**:**	16G7H01		**CIE**	**:**	100 Marks
Credits:	**:**	L:T:P :3:0:0		**SEE**	**:**	100 Marks
Hours	**:**	36L		**SEE Duration**	**:**	3.00 Hours

Course Learning Objectives: The students will be able to	
1	To have the basic knowledge of nanomaterials and the process.
2	Describe methods of nanoscale manufacturing and characterization can be enabled.
3	To learn about Nano sensors and their applications in mechanical, electrical, electronic, Magnetic, Chemical field.
4	To understand the concept for a nanoscale product based on sensing, transducing, and actuating mechanism.
5	To have awareness about the nanoscale products used in multidisciplinary fields.

Unit-I	**06 Hrs**
Introduction to Nanomaterials: History of Nanotechnology, structures and properties of carbon based: Fullerenes (Bucky Ball, Nanotubes), metal based: Nano Shells, Quantum Dots, Dendrimers, Diamond like carbon(DLC) Nanocarriers, bionanomaterails: protein & DNA based nanostructures, Hybrids: hybrid biological/inorganic, Nanosafety Issues: Toxicology health effects caused by nanoparticles.	
Unit – II	**08 Hrs**
Characterization of Nanostructures: Spectroscopy: UV-Visible spectroscopy, Fourier Transform infrared spectroscopy (FTIR), Raman Spectroscopy, X-ray spectroscopy. **Electron microscopy**: Scanning electron microscopy (SEM), Transmission electron microscopy (TEM).**Scanning probe microscopy**: Atomic Force microscopy (AFM), Scanning tunnel microscopy (STM). **Nano Synthesis and Fabrication**: Introduction & overview of Nanofabrication: Bottom up and Top down approaches using processes like Ball milling, Sol-gel Process, Chemical Vapour deposition (CVD), plsma arching and various lithography techniques (Hard & Soft lithography).	
Unit –III	**09 Hrs**
Nanosensors: Overview of nanosensors, prospects and market. Types of Nanosensors and their applications. Electromagnetic nanosensors: Electronic nose and electronic tongue, Magnetic nanosensors. Mechanical nanosensors: Cantilever Nanosensors, Mechanics of CNTs, Biosensors: Biosensors in modern medicine.	
Unit –IV	**06 Hrs**
. **Micro & Nano-Electromechanical systems and Microfluidics**: MEMS/NEMS: Magnetic, Chemical and Mechanical Transducers –Sensing and Actuators. Microfludics: Laminar flow, Hagen-Peouiselle equation, basic fluid ideas, Special considerations of flow in small channels, mixing, microvalves & micropumps.	
Unit –V	**07 Hrs**
Applications of Nanotechnology: Molecular electronics, molecular switches, mechanical cutting tools, machine components, DLC coated grinding wheels. solar cells, Batteries, fuel cells, Nanofilters. Medical nanotechnology: in Diagnostics, Therapeutics, Drug delivery and Nanosurgery.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Remember, understand, and apply knowledge about of nanomaterials and their uses.
CO2:	Interpret and apply the techniques of manufacturing and characterization processes
CO3:	Apply the knowledge of Nanosensors, related to nanosensors in electronics, mechanical, chemical, and biological systems.
CO4:	Create and evaluate nano Design, Devices and Systems in various disciplines

Reference Books	
1	B.S. Murty., P. Shankar., B.Raj, B..B. Rath, and J. Murday, Textbook of Nanosciences and Nanotechnology, Springer, Co-publication with University Press (India) Pvt. Ltd. VCH, XII.1st Edition, 2013, ISBN- 978-3-642-28030-6.
2	V. K. Khanna, Nanosensors:, Physical, Chemical and Biological, CRC press, 1st edition, 2013, ISBN 9781439827123 (Unit III).
3	C. C. Kock., Nanostructured materials, Nanostructured materials, William Andrew Publishing, 2nd edition, 2007, ISBN 0-8155-1534-0.
4	M .Wilson., K. Kannangara., G.Smith., M.Simmons., B. Raguse., Nanotechnology, , overseas Press (India) Private Ltd.,1st edition, 2005,ISBN 81-88689-20-3.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project 10.

Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Semester: VII						
INDUSTRIAL SAFETY AND RISK MANAGEMENT (Group H: Global Elective)						
Course Code	**:**	16G7H02		**CIE**	**:**	**100 Marks**
Credits:	**:**	L:T:P :3:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	36L		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Understand the basics of risk assessment methodologies
2	Select appropriate risk assessment techniques
3	Analyze public and individual perception of risk
4	Relate safety, ergonomics and human factors
5	Carry out risk assessment in process industries

Unit-I	**08 Hrs**
General Risk Identification Methods – I: Hazard identification methodologies, risk assessment methods-PHA, HAZOP, MCA, consequence analysis, hazards in workplaces-nature and type of work places, types of hazards, hazards due to improper housekeeping, hazards due to fire in multi floor industries and buildings.	
Unit – II	**07 Hrs**
Risk Assessment Methods – II: Risk adjusted discounted rate method, certainty equivalent coefficient method, quantitative analysis, probability distribution, coefficient of variation method, Simulation method, Shackle approach, Hiller‟s model, Hertz Model.	
Unit –III	**07 Hrs**
Risk Management – III: Emergency relief Systems, Diers program, bench scale experiments, design of emergency relief systems, risk management plan, mandatory technology option analysis, risk management alternatives, risk management tools, risk management plans, risk index method, Dowfire and explosion method, Mond index Method.	
Unit –IV	**07 Hrs**
Risk Assurance and Assessment – IV: Property insurance, transport insurance, liability insurance, risk Assessment, low Probability high consequence events. Fault tree analysis, Event tree analysis.	
Unit –V	**07Hrs**
Risk Analysis in Chemical Industries– V: Handling and storage of chemicals, process plants, personnel protection equipment's. International environmental management system.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Recall risk assessment techniques used in process industry
CO2:	Interpret the various risk assessment tools
CO3:	Use hazard identification tools for safety management
CO4:	Analyze tools and safety procedures for protection in process industries

Reference Books	
1	Kirkcaldy K.J.D Chauhan, Functional Safety in the Process Industry : A Handbook of practical Guidance in the application of IEC61511 and ANSI/ISA-84,North corolina, Lulu publication,2012,ISBN:1291187235
2	Goble and William M. Safety Instrumented Systems Verification Practical probabilistic calculations, Pensulvania ISA publication,2005,ISBN:155617909X
3	Laird Wilson and Doug Mc Cutcheon. Industrial safety and risk Management,The University of Alberta press,Canada, 1st Edition,2003,ISBN: 0888643942.

4	Sincero A P and Sincero G A Environmental Engineering – A Design Approach,Prentice Hall of India, New Delhi,1996, ISBN: 0024105643
5	Pandya C G, Risks in Chemical units, Oxford and IBH publications, New Delhi,1992,ISBN: 8120406907

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project 10.
Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)
SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Semester: VII						
INTELLIGENT TRANSPORT SYSTEM (Group H: Global Elective)						
Course Code	**:**	**16G7H03**		**CIE**	**:**	**100 Marks**
Credits:	**:**	**L:T:P : 3:0:0**		**SEE**	**:**	**100 Marks**
Hours	**:**	**36L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to	
1	Understand basic traffic flow and control for ITS
2	Understand user services for application in transportation system
3	Understand ITS architecture and its planning at various levels
4	Evaluate user services at various levels

Unit – I	**08 Hrs**
Introduction: –Historical Background, Definition, Future prospectus, ITS training and educational needs. **Fundamentals of Traffic Flow and Control**- Traffic flow elements, Traffic flow models, Shock waves in Traffic streams, Traffic signalization and control principles, Ramp metering, Traffic simulation	
Unit – II	**06 Hrs**
ITS User services-User services bundles, Travel and Traffic management, Public Transportation Operations, Electronic Payment, Commercial Vehicles Operations, Emergency Management, Advanced Vehicle Control and safety systems, Information Management, Maintenance and construction Management	
Unit –III	**07 Hrs**
ITS Applications and their benefits-Freeway and incident management systems-objectives, functions, traffic Surveillance and incident detection, Ramp control, incident management, Advanced arterial traffic control systems- historical development, Adaptive traffic control algorithms, Advanced Public Transportation Systems-Automatic vehicle location systems, Transit Operations software and information systems, Electronic fare payment systems, Multimodal Traveler Information systems	
Unit –IV	**07 Hrs**
ITS Architecture-Regional and Project ITS Architecture, Need of ITS architecture, concept of Operations, National ITS Architecture, Architecture development tool. **ITS Planning**-Transportation planning and ITS, Planning and the National ITS Architecture, Planning for ITS, Integrating ITS into Transportation Planning, relevant case studies.	
Unit –V	**08 Hrs**
ITS Standards-Standard development process, National ITS architecture and standards, ITS standards application areas, National Transportation Communications for ITS Protocol, Standards testing. **ITS Evaluation** – Project selection at the planning level, Deployment Tracking, Impact Assessment, Benefits by ITS components, Evaluation Guidelines, Challenges and Opportunities.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Identify various applications of ITS
CO2:	Apply ITS applications at different levels.
CO3:	Examine ITS architecture for planning process.
CO4:	Define the significance of ITS for various levels

Reference Books	
1	Choudury M A and Sadek A, "Fundamentals of Intelligent Transportation Systems Planning" Artech House publishers (31 March 2003); ISBN-10: 1580531601
2	Bob Williams, "Intelligent transportation systems standards" ,Artech House, London, 2008. ISBN-13: 978-1-59693-291-3.
3	Asier Perallos, Unai Hernandez-Jayo, Enrique Onieva, Ignacio Julio García Zuazola "Intelligent Transport Systems: Technologies and Applications" Wiley Publishing ©2015, ISBN:1118894782 9781118894781
4	ITS Hand Book 2000 Recommendations for World Road Association (PIARC) by Kan Paul Chen, John Miles.
5	Dominique Luzeaux ,Jean-René Ruault, Michel Chavret "Intelligent Transport Systems" 7 MAR 2013 Copyright © 2010 by John Wiley & Sons, Inc DOI: 10.1002/9781118557495.ch6

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for assignment is 10. The total marks of CIE are 100.
Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks are executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Semester: VII						
INTELLIGENT SYSTEMS **(Group H: Global Elective)**						
Course Code	**:**	**16G7H04**		**CIE**	**:**	**100 Marks**
Credits	**:**	**L:T:P 3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**36L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to	
1	Understand fundamental AI concepts and current issues.
2	Understand and apply a range of AI techniques including search, logic-based reasoning, neural networks and reasoning with uncertain information.
3	Recognize computational problems suited to an intelligent system solution.
4	Identify and list the basic issues of knowledge representation, blind and heuristic search.

Unit-I	**07 Hrs**
Introduction: The Foundations of Artificial Intelligence, History of Artificial Intelligence, The State of the Art, **Intelligent Agent:** Introduction, How Agents Should Act, Structure of Intelligent Agents, **Problem-solving**: Solving Problems by Searching Search Strategies, Avoiding Repeated States ,Avoiding Repeated States	
Unit – II	**07 Hrs**
Informed Search Methods: Best-First Search, Heuristic Functions, Memory Bounded Search, Iterative Improvement Algorithms **Game Playing:** Introduction: Games as Search Problems, Perfect Decisions in Two-Person, Games Imperfect Decisions, Alpha-Beta Pruning, Games That Include an Element of Chance	
Unit –III	**07 Hrs**
Knowledge Inference Knowledge representation -Production based system, Frame based system. Inference - Backward chaining, Forward chaining, Rule value approach, Fuzzy reasoning - Certainty factors, Bayes Rule, Uncertainty Principles, Bayesian Theory-Bayesian Network-Dempster - Shafer theory.	
Unit –IV	**07 Hrs**
Learning from Observations: A General Model of Learning Agents, Inductive Learning, Learning Decision Trees, Using Information Theory, Learning General Logical Descriptions, Why Learning Works: Computational Learning Theory **Reinforcement Learning:** Passive Learning in a Known Environment, Passive Learning in an Unknown Environment, Active Learning in an Unknown Environment	
Unit –V	**07 Hrs**
Expert Systems, Components, Production rules, Statistical reasoning, certainty factors,measure of belief and disbelief, Meta level knowledge, Introspection. Expert systems - Architecture of expert systems, Roles of expert systems - Knowledge Acquisition –Meta knowledge, Heuristics. Typical expert systems - MYCIN, DART, XOON, Expert systems shells.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understand and explore the basic concepts and challenges of Artificial Intelligence.
CO2:	Analyze and explain basic intelligent system algorithms to solve problems.
CO3:	Apply Artificial Intelligence and various logic-based techniques in real world problems.
CO4:	Assess their applicability by comparing different Intelligent System techniques

Reference Books	
1	AI – A Modern Approach ,Stuart Russel, Peter Norvig , 2nd Edition, Pearson Education, 2010, ISBN-13: 978-0137903955.
2	Artificial Intelligence (SIE) ,Kevin Night, Elaine Rich, Nair B., ,McGraw Hill, 1st Edition, 2008, ISBN: 9780070087705

3	Introduction to AI and ES ,Dan W. Patterson, Pearson Education, 1st Edition ,2007. ISBN: 0132097680
4	Introduction to Expert Systems ,Peter Jackson, 3rd Edition, Pearson Education, 2007, ISBN-978-0201876864

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 60 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project 10.
Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)
SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**1**	**2**	**-**	**2**	**2**
CO2	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**1**	**2**	**-**	**2**	**2**
CO3	**3**	**3**	**3**	**3**	**3**	**2**	**1**	**1**	**2**	**-**	**2**	**2**
CO4	**3**	**3**	**3**	**3**	**3**	**1**	**2**	**1**	**1**	**1**	**2**	**2**

High-3: Medium-2 : Low-1

Semester: VII						
IMAGE PROCESSING AND MACHINE LEARNING (Group H: Global Elective)						
Course Code	**:**	16G7H05		**CIE**	**:**	100 Marks
Credits:	**:**	L:T:P:S : 3:0:0:0		**SEE**	**:**	100 Marks
Total Hours	**:**	40L		**SEE Duration**	**:**	03 Hours

Course Learning Objectives: The students will be able to	
1	Understand the major concepts and techniques in image processing and Machine Learning
2	To explore, manipulate and analyze image processing techniques
3	To become familiar with regression methods, classification methods, clustering methods.
4	Demonstrate image processing and Machine Learning knowledge by designing and implementing algorithms to solve practical problems

Unit-I	**08 Hrs**
Introduction to image processing: Images, Pixels, Image resolution, PPI and DPI, Bitmap images, Lossless and lossy compression, Image file formats, Color spaces, Bezier curve, Ellipsoid, Gamma correction, Advanced image concepts	
Unit – II	**08 Hrs**
Basics of Python & Scikit image: Basics of python, variables & data types, data structures, control flow & conditional statements, uploading & viewing an image, Image resolution, gamma correction, determining structural similarities.	
Unit –III	**08 Hrs**
Advanced Image processing using Open CV Blending Two Images, Changing Contrast and Brightness Adding Text to Images Smoothing Images , Median Filter ,Gaussian Filter ,Bilateral Filter ,Changing the Shape of Images ,Effecting Image Thresholding ,Calculating Gradients , Performing Histogram Equalization	
Unit –IV	**08 Hrs**
Machine Learning Techniques in Image Processing Bayesian Classification, Maximum Likelihood Methods, Neural Networks; Non-parametric models; Manifold estimation, Support Vector Machines, Logistic Regression	
Unit –V	**08 Hrs**
Introduction to object Tracking , Modeling & Recognition Exhaustive vs. Stochastic Search, Shapes, Contours, and Appearance Models. Mean-shift tracking; Contour-based models, Adaboost approaches: Face Detection / Recognition, Tracking.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Gain knowledge about basic concepts of Image Processing
CO2:	Identify machine learning techniques suitable for a given problem
CO3:	Write programs for specific applications in image processing
CO4:	Apply different techniques for various applications using machine learning techniques.

Reference Books	
1	Practical Machine Learning and Image Processing: For Facial Recognition, Object Detection, and Pattern Recognition Using Python", by Himanshu Singh, Apress publisher.
2	Pattern Recognition and Machine Learning, by Christopher Bishop, Springer, 2008
3	Computer Vision: A modern Approach" by David Forsyth and Jean Ponce, Prentice Hall India 2004.
4	Machine Vision : Theory Algorithms Practicalities ,by E.R. Davies Elsevier 2005.
5	Digital Image Processing, Rafael C. Gonzalez and Richard E. Woods Pearson Education, Ed, 2001.

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project 10.
Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)
SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

SEMESTER: VII						
DESIGN OF RENEWABLE ENERGY SYSTEMS (GROUP H: GLOBAL ELECTIVE)						
Course Code	**:**	**16G7H06**		**CIE Marks**	**:**	**100**
Credits:	**:**	**L:T:P:S : 3:0:0**		**SEE Marks**	**:**	**100**
Total Hours	**:**	**40L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives:	
1	To provide opportunity for students to work on multidisciplinary projects.
2	To familiarize the students with the basic concepts of nonconventional energy sources and allied technological systems for energy conversion
3	To impart skill to formulate, solve and analyze basic Non – conventional energy problems and prepare them for graduate studies.
4	To enable the student to design primarily solar and wind power systems.
5	To expose the students to various applications of solar, wind and tidal systems.

UNIT – I	**07 Hrs**
An introduction to energy sources: Industry overview, incentives for renewable, utility perspective, Relevant problems discussion, current positions of renewable energy conditions	
UNIT – II	
PV Technology: photovoltaic power, PV projects, Building-integrated PV system, PV cell technologies, solar energy maps, Technology trends, **Photovoltaic Power Systems**: PV cell, Module and Array, Equivalent electrical circuit, open-circuit voltage and short-circuit current, I-V and P-V curves, Array design (different methodologies), peak-power operation, system components.	
UNIT – III	**09 Hrs**
Wind Speed and Energy: Speed and power relations, power extracted from the wind, Air density, Global wind patterns, wind speed distribution (parameters calculations) , wind speed prediction, **Wind Power Systems :** system components , turbine rating , power vs. speed and TSR, maximum energy capture, maximum power operation, system-design trade-offs , system control requirements, environmental aspects.	
UNIT – IV	**07 Hrs**
Geothermal and ocean energy: Geothermal power, geo pressured sources, Geothermal well drilling, advantages and disadvantages, Comparison of flashed steam and total flow concept **Energy from ocean**: OTEC power generation, OPEN and CLOSED cycle OTEC. Estimate of Energy and power in simple single basin tidal and double basin tidal system	
UNIT – V	**08 Hrs**
Stand alone system: PV stand-alone, Electric vehicle, wind standalone, hybrid systems (case study), system sizing, wind farm sizing. **Grid-Connected Systems: i**ntroduction**,** interface requirements, synchronizing with the grid, operating limit, Energy storage and load scheduling**,** Grid stability issues**,** distributed power generation.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Demonstrate an understanding of the scientific principles of methodology of Non-conventional energy.
CO2:	Acquire working knowledge of different Renewable energy science-related topics.
CO3:	Ability to analyze the system related concepts effectively in the wind energy designing.
CO4:	Students will be able to decide the appropriate procedures to ensure that the working model has developed properly.

Reference Books	
1.	Wind and Solar Power Systems Design, Analysis and operation, Mukund R Patel, 2nd Edition, 2006, Taylor and Francis publishers, ISBN 978-0-8493-1570-1.
2.	Non-Conventional sources of energy, G.D.Rai, 4th Edition, 2009, Khanna Publishers, ISBN 8174090738, 9788174090737,
3.	Solar Energy, Sukhatme, 4th Edition, 2017, McGraw Hill Education, **ISBN-13:** 978-9352607112
4.	Renewable energy sources, John Twidell, Tony Weir, 3rd Edition, 2015, Routledge Publisher, ISBN-13: 978-0415584388.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project 10.

Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

VII Semester						
SYSTEMS ENGINEERING (Group H: Global Elective)						
Course Code	**:**	**16G7H07**		**CIE Marks**	**:**	**100**
Credits:	**:**	**L:T:P:S :3:0:0:0**		**SEE Marks**	**:**	**100**
Total Hours	**:**	**33L**		**SEE Duration**	**:**	**03 Hours**

Course Learning Objectives:

1	Develop an appreciation and understanding of the role of systems engineering processes and systems management in producing products and services.
2	Document systematic measurement approaches for generally cross disciplinary development effort.
3	Discuss capability assessment models to evaluate and improve orgnizational systems engineering capabilities.

Unit-I	**07 Hrs**
System Engineering and the World of Modem System: What is System Engineering?, Origins of System Engineering, Examples of Systems Requiring Systems Engineering, System Engineering viewpoint, Systems Engineering as a Profession, The power of Systems Engineering, problems. **Structure of Complex Systems:** System building blocks and interfaces, Hierarchy of Complex systems, System building blocks, The system environment, Interfaces and Interactions. **The System Development Process:** Systems Engineering through the system Life Cycle, Evolutionary Characteristics of the development process, The system engineering method, Testing throughout system development, problems.	
Unit – II	**07 Hrs**
Systems Engineering Management: Managing systems development and risks, Work breakdown structure (WBS), System Engineering Management Plan (SEMP), Risk Management, Organization of Systems Engineering, Systems Engineering Capability Maturity Assessment, Systems Engineering standards, Problem. **Needs Analysis:** Originating a new system, Operations analysis, Functional analysis, Feasibility analysis, Feasibility definition, Needs validation, System operational requirements, problems. **Concept Exploration:** Developing the system requirements, Operational requirements analysis, Performance requirements formulation, Implementation concept exploration, Performance requirements validation, problems.	
Unit – III	**07 Hrs**
Concept Definition: Selecting the system concept, Performance requirements analysis, Functional analysis and formulation, Concept selection, Concept validation, System Development planning, System Functional Specifications, problems **Advanced Development:** Reducing program risks, Requirements analysis, Functional Analysis and Design, Prototype development, Development testing, Risk reduction, problems.	
Unit – IV	**06 Hrs**
Engineering Design: Implementing the System Building blocks, requirements analysis, Functional analysis and design, Component design, Design validation, Configuration Management, problems. **Integration and Evaluation:** Integrating, Testing and evaluating the total system, Test planning and preparation, System integration, Developmental system testing, Operational test and evaluation, problems.	
Unit – V	**06 Hrs**
Production: Systems Engineering in the factory, Engineering for production, Transition from development to production, Production operations, Acquiring a production knowledge base, problems. **Operations and support**: Installing, maintenance and upgrading the system, Installation and test, In-service support, Major system upgrades: Modernization, Operational factors in system development, problems.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the Life Cycle of Systems.
CO2	Explain the role of Stake holders and their needs in organizational systems.
CO3	Develop and Document the knowledge base for effective systems engineering processes.
CO4	Apply available tools, methods and technologies to support complex high technology systems.
CO5	Create the frameworks for quality processes to ensure high reliability of systems.

Semester: VII						
MEMS AND APPLICATIONS (Group H: Global Elective)						
Course Code	**:**	**16G7H08**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**35L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Understand the rudiments of Micro fabrication techniques.
2	Identify and associate the various sensors and actuators to applications.
3	Analyze different materials used for MEMS.
4	Design applications of MEMS to disciplines.

Unit - I	**06 Hrs**
Overview of MEMS & Microsystems: MEMS and Microsystems, Typical MEMS and micro system products, Evolution of micro fabrication, Microsystems and microelectronics, Multidisciplinary nature of Microsystems, Design and manufacture, Applications of Microsystems in automotive, healthcare, aerospace and other industries. **Working Principle of Microsystems**: Biomedical and biosensors. Micro sensors: Acoustic, Chemical, Optical, Pressure, Thermal.	
Unit – II	**08 Hrs**
Micro actuation: Using thermal forces, shape memory alloys, Piezoelectric crystals and electrostatic forces. MEMS with micro actuators: Microgrippers, micromotors, microvalves and micropumps, microaccelerometers, microfluidics**.** **Introduction to Scaling:** Scaling in Geometry, Scaling in Rigid body dynamics, Scaling in Electrostatic forces, scaling in electromagnetic forces and scaling in fluid mechanics.	
Unit – III	**08 Hrs**
Materials for MEMS and Microsystems: Substrates and wafers, Active substrate materials, Silicon as substrate material, Silicon Compounds, Si-Piezoresistors, GaAs, Quartz, Piezoelectric Crystals, Polymers and packaging materials. Three level of Microsystem packaging, Die level packaging, Device level packaging, System level packaging. Interfaces in microsystem packaging. Essential packaging technologies: die preparation, Surface bonding, Wire bonding, Sealing, 3D packaging.	
Unit – IV	**06 Hrs**
Microsystem Fabrication Process: Introduction to microsystems, Photolithography, Ion Implantation, Diffusion, Oxidation, CVD,PVD-Sputtering, Deposition of Epiaxy, Etching, LIGA process: General description, Materials for substrates and photoresists, Electroplating and SLIGA process.	
Unit – V	**07 Hrs**
Tactile and Flow sensors – Piezoelectric sensors and actuators – piezoelectric effects – piezoelectric materials – Applications to Inertia, Acoustic, Tactile and Flow sensors. **Overview, Application, Fabrication Process in Applications:** Silicon Capacitive Accelerometer, Piezo resistive Pressure sensor, Electrostatic Comb drive, Portable blood analyzer, Piezo electric Inkjet Print head, Micromirror array for Video projection.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understand the operation of micro devices, micro systems and their applications.
CO2:	Apply the principle of material science to sensor design.
CO3:	Analyze the materials used for sensor designs.
CO4:	Conceptualize and design micro devices, micro systems.

Reference Books	
1	MEMS & Microsystems Design and Manufacture, Tai-Ran Hsu, 2nd Edition, 2002, Tata McGraw Hill Education, New Delhi, ISBN-13:978-0-07-048709-3.
2	Foundations of MEMS, Chang Liu, 2012, Pearson Education Inc., ISBN-13:978-0-13-249736-7.
3	Smart Material Systems and MEMS, Vijay K Varadan, K. J. Vinoy, S. Gopalakrishnan, 2006, Wiley-INDIA, ISBN-978-81-265-3170-7.
4	Micro and Smart Systems, G.K. Ananthasuresh, K.J .Vinoy, K.N. Bhat, V.K. Aatre, 2015, Wiley Publications, ISBN-:978-81-265-2715-1.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Self-Study(S). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for assignment is 10. The marks component for Assignment is 10.
Total CIE is 30(Q) + 60(T) + 10(A) =100.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Semester: VII						
INTRODUCTION TO INTERNET OF THINGS (Group H: Global Elective)						
Course Code	**:**	**16G7H09**		**CIE**	**:**	**100 Marks**
Credits:	**:**	**L:T:P :3:0:0**		**SEE**	**:**	**100 Marks**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to	
1	Learn the fundamentals of IoT
2	Understands the hardware, networks & protocols used in IoT development
3	Illustrate smart applications using IoT devices and building applications
4	Know more advanced concepts like cloud connectivity in IoT
5	Learn the fundamentals of IoT

Unit-I	**06 Hrs**
Fundamentals Of IOT: Introduction, Physical design of IoT, Logical design of IoT, IoT Enabling technologies, IoT Levels and Deployment Templates, , IoTvs M2M	
Unit – II	**06 Hrs**
IOT Design Methodology: Need for IoT systems management, IoT Design Methodology **Internet of Things Strategic Research and Innovation Agenda:** Internet of Things Vision, IoT Strategic Research and Innovation Directions, IoT Smart-X Applications, Internet of Things and Related Future Internet Technologies.	
Unit –III	**11 Hrs**
IOT Systems - Logical Design using Python: Provides an introduction to Python, installing Python, Python data types & data structures, control flow, functions, modules, packages, file input/output, data/time operations and classes.	
Unit –IV	**09 Hrs**
IOT Physical Devices & Endpoints: What is an IoT device, Raspberry Pi device, About the board, Linux on Raspberry Pi, Raspberry Pi interfaces, Programming Raspberry Pi with Python.	
Unit –V	**07 Hrs**
IOT Physical Servers & Cloud Offerings: Provides an introduction to the use of cloud platforms and frameworks such as Xively and AWS for developing IoT applications.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understand the fundamentals of IoT.
CO2:	Analyse the IoT devices, programming, networking requirements and protocols for building IoT products.
CO3:	Apply the concepts to design and develop IoT applications
CO4:	Creating applications of IoT using physical devices and interfacing with cloud.

Reference Books	
1	Internet of Things (A Hands-on-Approach), Vijay Madisetti and ArshdeepBahga, 1st Edition, VPT, 2014, ISBN-13: 978-0996025515.
2	Internet of Things – From Research and Innovation to Market Deployment, OvidiuVermesan, Peter Friess, River Publishers Series in Communication, River Publishers, 2014, ISBN: ISBN: 978-87-93102-94-1 (Hard copy), 978-87-93102-95-8 (Ebook) (UnitsII 2nd part)
3	Rethinking the Internet of Things: A Scalable Approach to Connecting Everything, Francis daCosta, , 1st Edition, Apress Publications, 2013, ISBN-13: 978-1430257400.
4	Meta products - Building the Internet of Things, WimerHazenberg, Menno Huisman, BIS Publishers, 2012, ISBN: 9789863692515.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project 10.

Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Semester: VII						
INDUSTRY 4.0– SMART MANUFACTURING FOR THE FUTURE (Group H: Global Elective)						
Course Code	**:**	16G7H10		**CIE**	**:**	**100 Marks**
Credits:	**:**	L:T:P :3:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	39L		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Understand the importance and role of Smart Manufacturing Systems, IoT and IIoT
2	Explain importance of automation technologies, sensors, Robotics and Machine vision.
3	Understand application of artificial intelligence and the need for data transformation, handling, storing and security.
4	Understand simulation, predictive and knowledge modeling along with analysis
5	Learn networking, sustainable technology and factory networks.

Unit-I	**06 Hrs**
Smart Manufacturing and Industry 4.0 Need for Smart Manufacturing, Advantages, Emerging technologies in Smart manufacturing, CAD Architecture surrounding 3D Models (B-rep and CSG), MEMS, Industry 4.0–Interoperability, Information transparency, Technical assistance, Decentralized decision-making, Internet of Things(IoT), Industry Internet of Things (IIoT), Future of Manufacturing industries	
Unit – II	**09 Hrs**
Manufacturing Automation Technology intensive manufacturing and cyber-physical systems, Automation using Robotics, Data storage, retrieval, manipulation and presentation; Mechanisms for sensing state and modifying processes, Material handling systems, controlling material movement and machine flow, Mechatronics, Transducers and sensors, Proximity sensors, Biosensors, Acceleration Machine Vision–Flaw detection, Positioning, Identification, Verification and Measurement–Application of Machine Vision in industries	
Unit –III	**09 Hrs**
Data handling using Embedded Systems Data transformation–Mathematical functions, Regression, Need for different functions, Data merging–Discrete and Random variables, Transformation languages, Interfacing systems-Microprocessors, Direct memory access, Data transfer schemes and systems, Communication systems–Modulation, Time domain and frequency domain, Industrial Network Data Communications, Data Security Artificial Intelligence – Intelligent systems, Fuzzy logics, Neural networks – Supervised, Unsupervised and Reinforced learning	
Unit –IV	**06 Hrs**
Simulation, Modeling and Analysis Simulation - system entities, input variables, performance measures, and Functional relationships, types of simulation. Predictive modeling and simulation tools, Knowledge Modeling –types and technology options, Functional analysis of control systems – Linear and Non-linear, Functional decomposition, Functional sequencing, Information / dataflow, Interface	
Unit –V	**09 Hrs**
Performance Measures of Smart Manufacturing Systems- Smart manufacturing- Sensing and Perception, Manipulation, Mobility and Autonomy, Factory Networks, Information Modeling and Testing, Performance Measurement and Optimization, Engineering System integration, Production Network integration, Production network data quality, Sustainable Processes and Resources, Integration Infrastructure for Sustainable Manufacturing	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Explain role and importance of Smart Manufacturing Systems, IoT and IIoT
CO2:	Explain importance of automation technologies, sensors, robotics and machine vision
CO3:	Illustrate the application of artificial intelligence and need for data transformation, handling
CO4:	Explain analytical and simulation for performance study of smart technologies and networks

Reference Books	
1	Zongwei Luo, Smart Manufacturing Innovation and Transformation: Interconnection And Intelligence, 1st Edition, IGI Global Publications, 2014,ISBN-13: 978-1466658363 ISBN-10: 1466658363
2	Yan Lu. KC Morris, Simon Frechette, Smart Manufacturing Standards, NIST, 1st Edition, 2016, Project report.

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project 10.
Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)
SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Semester: VII						
SPACE TECHNOLOGY AND APPLICATIONS (Group H: Global Elective)						
Course Code	**:**	**16G7H11**		**CIE**	**:**	**100 Marks**
Credits:	**:**	**L:T:P :S: 3 : 0 : 0 : 0**		**SEE**	**:**	**100 Marks**
Hrs/Week	**:**	**35L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to	
1	Define the earth environment and its behavior, launching vehicles for satellites and its associated concepts.
2	Analyze satellites in terms of technology, structure and communications.
3	Use satellites for space applications, remote sensing and metrology.
4	Apply the space technology, technology mission and advanced space systems to nation's growth.

UNIT-I	**07 Hrs**
Earth's environment: Atmosphere, ionosphere, Magnetosphere, Van Allen Radiation belts, Interplanetary medium, Solar wind, Solar- Earth Weather Relations. **Launch Vehicles:** Rocketry, Propellants, Propulsion, Combustion, Solid, Liquid and Cryogenic engines, Control and Guidance system, Ion propulsion and Nuclear Propulsion.	
UNIT-II	**07 Hrs**
Satellite Technology: Structural, Mechanical, Thermal, Power control, Telemetry, Telecomm and Quality and Reliability, Payloads, Space simulation. **Satellite structure:** Satellite Communications, Transponders, Satellite antennas.	
UNIT-III	**07 Hrs**
Satellite Communications: LEO, MEO and GEO orbits, Altitude and orbit controls, Multiple Access Techniques. **Space applications:** Telephony, V-SAT, DBS system, Satellite Radio and TV, Tele-Education, Tele-medicine, Satellite navigation, GPS.	
UNIT-IV	**07 Hrs**
Remote Sensing: Visual bands, Agricultural, Crop vegetation, Forestry, water Resources, Land use, Land mapping, geology, Urban development resource Management, and image processing techniques. **Metrology:** Weather forecast (Long term and Short term), weather modelling, Cyclone predictions, Disaster and flood warning, rainfall predictions using satellites.	
UNIT-V	**07Hrs**
Satellite payloads: Technology missions, deep space planetary missions, Lunar missions, zero gravity experiments, space biology and International space Missions. **Advanced space systems:** Remote sensing cameras, planetary payloads, space shuttle, space station, Inter-space communication systems.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain different types of satellites, orbit and associated subsystems.
CO2	Apply the basics of launching vehicles, satellites and sub systems for space applications.
CO3	Analyze the applications of satellite in the area of communication, remote sensing, metrology etc.,
CO4	Study technology trends, satellite missions and advanced space systems.

Reference Books	
1	Atmosphere, weather and climate, R G Barry, Routledge publications, 2009, ISBN- 10 :0415465702.
2	Fundamentals of Satellite Communication, K N Raja Rao, PHI, 2012, ISBN:9788120324015.
3	Satellite Communication, Timothy pratt, John Wiley, 1986 ISBN: 978-0- 471- 37007 -9, ISBN 10: 047137007X.

4	Remote sensing and applications, B C Panda, VIVA books Pvt. Ltd., 2009, ISBN: 108176496308.

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project 10.
Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)
SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Semester: VII						
ADVANCED LINEAR ALGEBRA (Group H: Global Elective)						
Course Code	**:**	**16G7H12**		**CIE**	**:**	**100 Marks**
Credits:	**:**	**L:T:P :3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Adequate exposure to learn the fundamental concepts to model a system of linear equations and to obtain the solution of system of linear equations.
2	Analyze and extend the structure of vector spaces, linear transformations, Symmetric matrices, quadratic forms required in applications of Business, Science and Engineering.
3	Apply the concept of Eigenvalues to study differential equations and dynamical systems. Apply the concept of Orthogonality to examine some of the least-squares problems.
4	Apply Linear Programming to Network problems and Game theory.

Unit-I	**07 Hrs**
System of linear equations Matrices and system of linear equations, Geometry of linear equations, Linear models in Business, Science and Engineering-Input-Output model in Economics, Balancing chemical equations and Electrical networks.	
Unit – II	**09 Hrs**
Vector spaces and linear transformations Revision of Vector Spaces, Subspaces, Linear independence, Basis, Dimension and Change of basis. Applications to Difference equations, Markov chains. Intersection, Sum, Product of spaces and Tensor product of two vector spaces. Introduction to Linear transformations, Geometrical interpretations in 2-dimensions and 3-dimensions.	
Unit –III	**09 Hrs**
Orthogonality, Eigen values and Eigen vectors Orthogonality, Inner product spaces, Applications to Weighted least-squares and Fourier series, Fast Fourier transform. Eigen values and Eigen vectors, Applications to Differential equations, Discrete dynamical systems.	
Unit –IV	**07 Hrs**
Symmetric matrices and quadratic forms Introduction to symmetric matrices, Quadratic forms, Test for Positive definiteness, Constrained Optimization, Singular Value Decomposition. Applications to image processing.	
Unit –V	**07 Hrs**
Linear programming and game theory A Geometrical introduction to Linear programming, Simplex method and its geometrical meaning, Network models-Max flow-min cut theorem, Payoff matrix and Matrix games.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Identify and interpret the fundamental concepts of linear equations, vector spaces, linear transformations, Orthogonality, Eigen values, symmetric matrices, quadratic forms, linear programming and game theory.
CO2:	Apply the knowledge and skills of Linear algebra to solve linear equations, difference and differential equations, constrained optimization problems, linear programming problems and related problems.
CO3:	Analyze the input-output models, Markov chains, discrete dynamical systems, singular value decomposition, network models and related problems.
CO4:	Using the overall mathematical knowledge of Linear Algebra to solve problems arising in practical situations.

Reference Books	
1	David C Lay; Linear Algebra and Its Applications; Pearson Education; III Edition; 2003; ISBN: 978-81-775-8333-5.
2	Gareth Williams; Linear Algebra with Applications; 6th edition; 2008; Narosa publications; ISBN: 978-81-7319-981-3.
3	Gilbert Strang; Linear Algebra and Its Applications; IV Edition; Cengage Learning India Edition; 2006; ISBN: 81-315-0172-8.
4	Howard Anton and Chris Rorres; Elementary Linear Algebra Applications Version; Wiley Global Education; 11th Edition; 2013; ISBN: 9781118879160.

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 60 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project 10.
Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)
SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	-	1	-	-	-	-	-	-	-	2
CO2	3	2	1	-	-	-	-	-	-	-	-	2
CO3	2	3	2	2	-	-	-	-	-	-	-	1
CO4	3	3	1	2	1	-	-	-	-	-	-	3

High-3: Medium-2 : Low-1

Semester: VII						
THIN FILM NANOTECHNOLOGY (Group H: Global Elective)						
Course Code	**:**	**16G7H13**		**CIE**	**:**	**100 Marks**
Credits	**:**	**L:T:P :3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Understand the importance of vacuum in thin film fabrication
2	Acquire the knowledge of thin film preparation by various techniques
3	Analyze the properties of thin films using different characterization methods
4	Optimize the process parameter and property dependence
5	Apply the knowledge for developing thin film devices.

Unit-I	**08 Hrs**
Vacuum Technology: Basics of Vacuum - Principles of different vacuum pumps: Rotary, Roots, Diffusion, Turbo molecular and Cryogenic pumps; Measurement of vacuum - Concept of Capacitance Manometer, Pirani and Penning gauges - Vacuum Systems & Applications.	
Unit – II	**08 Hrs**
Methods of thin film preparation Physical Vapor Deposition (PVD) Techniques**:** *Evaporation*: Thermal evaporation, Electron beam evaporation, Laser ablation, and Cathode arc deposition. *Sputtering*: DC sputtering, RF Sputtering, Magnetron sputtering, Reactive Sputtering, and Ion beam sputtering. Chemical Vapor Deposition (CVD) Techniques**:** Conventional CVD, Plasma Enhance CVD (PECVD) and Atomic layer deposition (ALD). Other Methods: Spin coating and Spray Pyrolysis.	
Unit –III	**07 Hrs**
Surface Modification and Growth of Thin Films: Surface preparation & Engineering for Thin film growth: Cleaning, Modification, Masking & Patterning, Base Coats and Top Coats. Thin Film growth: Sequence of thin film growth, Defects and impurities, Effect of Deposition Parameters on film growth.	
Unit –IV	**08 Hrs**
Properties and Characterization of Thin Films Film thickness (Quartz crystal thickness monitor and Stylus Profiler); Film Adhesion (Tape, Cross-hatch test, and Humidity methods); Surface morphology and topography (SEM and AFM); Film composition (X-ray Photoelectron Spectroscopy); Film structure (X-ray diffraction and Raman studies); Electrical characterization (Four Probe and Semiconductor Analyzer); and Optical characterization (Spectrophotometer).	
Unit –V	**08 Hrs**
Thin Film Applications: ▪ Electrodes: Deposition of a Metal film, Ex: Aluminum. ▪ Transparent conducting oxides (TCO) – Preparation and Optimization of a semiconducting film, Ex: ZnO. ▪ Optimization of a dielectric film, Ex: Al_2O_3 or Si_3N_4. **Thin Film Devices**: • Thin Film Transistors (TFT), • Thin Film Sensors • Thin Film Capacitors • Thin film Solar Cells,	

• Thin film Solar Absorbers ▪ Diamond-like carbon (DLC) coating ▪ EMI Shielding coatings ▪ Hard coatings Coatings on Plastics/Polymers.

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the importance of vacuum technology for thin film growth
CO2	Prepare various kinds of thin films using different deposition techniques
CO3	Characterize the deposited films for various properties
CO4	Fabricate thin film based devices.

Reference Books	
1.	Vacuum Technology by A. Roth, Elsevier, 3rd Edition, 1976, ISBN: 9780444880109, 9780444598745,
2.	Thin Film Phenomenon by K.L. Chopra, McGraw-Hill, 1st Edition, 1969, ISBN: 0070107998, 978-0070107991
3.	Materials Science of Thin Films by Milton Ohring, Elsevier, 2rdEdition, 2001, **ISBN:** 9780125249751
4.	Thin-Film Deposition: Principles and Practice by Donald Smith, McGraw-Hill, 1st Edition, 1995, ISBN: 0070585024, 9780070585027

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 60 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project 10.
Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)
SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1			**1**									**2**
CO2				**2**								**2**
CO3					**2**							**2**
CO4			**2**	**2**	**2**		**2**		**2**	**2**		**2**

High-3; Medium-2; Low-1

Semester: VII						
ENGINEERING MATERIALS FOR ADVANCED TECHNOLOGY (Group H: Global Elective)						
Course Code	**:**	**16G7H14**		**CIE**	**:**	100 **Marks**
Credits	**:**	**L:T:P :3:0:0**		**SEE**	**:**	100 **Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	3.00 **Hours**
Course Learning Objectives: The students will be able to						
1	Apply the basic concepts of Chemistry to develop futuristic materials for high-tech applications in the area of Engineering.					
2	Impart sound knowledge in the different fields of material chemistry so as to apply it to the problems in engineering field.					
3	Develop analytical capabilities of students so that they can characterize, transform and use materials in engineering and apply knowledge gained in solving related engineering problems.					

UNIT-I	**08 Hrs**
Coating and packaging materials **Surface Coating materials**: Synthesis and applications of Polymer coating materials: Teflon, Silicone films Polyvinyl chloride & its copolymers, Poly vinyl acetate, Poly ethylene-HDPE, LDPE, Polyurethane. Properties required in a pigment and extenders. Inorganic pigments-titanium dioxide, zinc oxide, carbon black, chromate pigments, chrome green, ultramarine blue, iron blue, cadmium red. **Corrosion inhibiting pigments-** zinc phosphate, zinc and barium chromate pigments, ceramic pigments, metal flake pigments, extenders. Developments in new polymers such as dendrimers, biopoplymers & biodegradable polymers. **Packaging materials:** Food products: Cellulosic and Polymeric packaging materials and their properties – including barrier properties, strength properties, optical properties. Glass, aluminium, tin, paper, plastics, composites. **Pharmaceutical products:** Injectibles and tablet packaging materials.	
UNIT-II	**07 Hrs**
Adhesives Introduction-Classification of Adhesives-Natural adhesives, synthetic adhesives-drying adhesives, pressure sensitive adhesives, contact adhesives, hot adhesives. One part adhesives, multi part adhesives. Adhesive Action. Development of Adhesive strength- Physical factors influencing Adhesive Action-surface tension, surface smoothness, thickness of adhesive film, elasticity and tensile strength. Chemical Factors Influencing Adhesive action - presence of polar groups, degree of polymerization, complexity of the adhesive molecules, effect of pH. Adhesive action- specific adhesive action, mechanical adhesive action, fusion adhesion. Development of adhesive strength- adsorption theory and diffusion theory. Preparation, curing and bonding Processes by adhesives-with reference to Epoxy, phenolics, Silicone, Polyurethane, Acrylic adhesives, Poly vinyl alcohol, Polyvinyl acetate.	
UNIT-III	**08 Hrs**
Optical fibre materials Fiber Optics, Advantages of optical fiber communication over analog communication, Classification based on refractive index of the core- step index and graded index optical fibres, Classification based on core radius-single mode and multimode optical fibres, Fibre fabrication.-Methods to manufacture optical glass fibres. Double crucible method and preform methods. Manufacture of perform- Chemical Vapour Deposition (CVD), Modified vapour deposition (MCVD) Plasma activated vapour deposition (PCVD), Outside vapour deposition (OVD)-Vapour-phase axial deposition (VAD). Drawing the fibres from perform, coating and jacketing process.	

Ion exchange resins and membranes

Ion exchange resins-Introduction, Types, physical properties, chemical properties-capacity, swelling, kinetics, stability, ion exchange equilibrium, regeneration. Applications of ion exchange resins-softening of water, demineralization of water, advantages and disadvantages of ion exchange resins-calcium sulphate fouling, iron fouling, adsorption of organic matter, bacterial contamination. Ion exchange membranes, Types, Classification, Fabrication of ion exchange cottons- anion exchange cotton and cation exchange cotton. Application of ion exchange membranes in purification of water by electro dialysis method.

UNIT-IV	**08 Hrs**

Spectroscopic Characterization of materials:

Electromagnetic radiation, interaction of materials with electromagnetic radiation.

UV- visible spectrophotometry :Introduction-Electronic transitions- factors influencing position and intensity of absorption bands-absorption spectra of dienes, polyene and α,β-unsaturated carbonyl compounds, Working of UV-Vis spectrophotometer, Theoretical calculation of λ_{max} by using Woodward-Fieser rules- for cyclic and α,β-unsaturated carbonyl compounds.

IR Spectroscopy: Introduction, principle, molecular vibrations, vibrational frequency, number of fundamental vibrations, factors influencing fundamental vibrations, instrumentation of IR spectrophotometer, sampling techniques and application of IR spectroscopy in characterization of functional groups.

UNIT-V	**08 Hrs**

NMR spectroscopy:

H^1 NMR Spectroscopy: Basic concepts- relaxation process. NMR spectrometer-FT NMR-Solvents used in NMR, internal standards-Chemical equivalence -Integrals and Integrations- chemical shift-Factors affecting chemical shifts- shielding and deshielding effects – chemical and magnetic equivalent –magnetic anisotropy-spin-spin splitting rules- Application of NMR on various compounds such as alkanes, alkenes, alkynes, alkyl halides, alcohols, ethers, amines, aldehydes, ketones, carboxylic acids, esters, amides & mono substituted aromatic compounds. Problems on prediction of structure of compounds.

Course Outcomes: After completing the course, the students will be able to	
CO1	Identify sustainable engineering materials and understand their properties.
CO2	Apply the basic concepts of chemistry to develop futuristic materials for high-tech applications in different areas of engineering.
CO3	Analyze and evaluate the specific application of materials.
CO4	Design the route for synthesis of material and its characterization.

Reference Books	
1.	Materials Science, G.K.Narula, K.S.Narula & V.K.Gupta. 38th Edtion, 2015, Tata McGraw-Hill Publishing Company Limited ISBN: 978-0-07-451796-3.
2.	Solar Lighting, Ramachandra Pode and Boucar Diouf, Springer e-book, 2011, ISBN: 978-1-44-712133-6 (Print) 978-1-44-712134-3 (Online),
3.	Spectroscopy of organic compounds, P.S.Kalsi, 6th Edition, 2013, New Age International(P) ltd,publisher, ISBN: 978-1-22-415438-6.
4.	Food Packaging Materials, Mahadeviah M & Gowramma RV, 6th Edition, 1996, Tata McGraw Hill Publishing Company Ltd, ISBN :746-2-23-82 9780-0.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project 10. **Total CIE is 30(Q) +60(T) +10(A) =100 Marks.**

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Semester: VII (Global elective)						
APPLIED PSYCHOLOGY FOR ENGINEERS (Group H: Global Elective)						
Course Code	**:**	**16G7H15**		**CIE**	**:**	**100**
Credits	**:**	**L:T:P :3:0:0**		**SEE**	**:**	**100**
Total Hours	**:**	**35**		**SEE Duration**	**:**	**3 Hours**

Course Learning Objectives: The students will be able to

1	To appreciate human behavior and human mind in the context of learner's immediate society and environment.
2	To understand the importance of lifelong learning and personal flexibility to sustain personal and Professional development as the nature of work evolves.
3	To provide students with knowledge and skills for building firm foundation for the suitable engineering professions.
4	To prepare students to function as effective Engineering Psychologists in an Industrial, Governmental or consulting organization.
5	To enable students to use psychological knowledge, skills, and values in occupational pursuits in a variety of settings that meet personal goals and societal needs.

Unit – I	**07 Hrs**
Introduction to Psychology: Definition and goals of Psychology: Role of a Psychologist in the Society: Today's Perspectives (Branches of psychology). Psychodynamic, Behavioristic, Cognitive, Humanistic, Psychological Research and Methods to study Human Behavior: Experimental, Observation, Questionnaire and Clinical Method.	
Unit - II	**07 Hrs**
Intelligence and Aptitude: Concept and definition of Intelligence and Aptitude, Nature of Intelligence. Theories of Intelligence – Spearman, Thurston, Guilford Vernon. Characteristics of Intelligence tests, Types of tests. Measurement of Intelligence and Aptitude, Concept of IQ, Measurement of Multiple Intelligence – Fluid and Crystallized Intelligence.	
Unit – III	**07 Hrs**
Personality: Concept and definition of personality, Approaches of personality- psychoanalytical, Socio- Cultural, Interpersonal and developmental, Humanistic, Behaviorist, Trait and type approaches. Assessment of Personality: Self- report measures of Personality, Questionnaires, Rating Scales and Projective techniques, its Characteristics, advantages & limitations, examples. Behavioral Assessment. Psychological Stress: a. Stress- Definition, Symptoms of Stress, Extreme products of stress v s Burnout, Work Place Trauma. Causes of Stress – Job related causes of stress. Sources of Frustration, Stress and Job Performance, Stress Vulnerability-Stress threshold, perceived control.	
Unit – IV	**07 Hrs**
Application of Psychology in Working Environment: The present scenario of information technology, the role of psychologist in the organization, Selection and Training of Psychology Professionals to work in the field of Information Technology. Distance learning, Psychological consequences of recent developments in Information Technology. Type A and Type B Psychological Counseling - Need for Counseling, Types – Directed, Non- Directed, Participative Counseling.	
Unit – V	**07 Hrs**
Learning: Definition, Conditioning – Classical Conditioning, Basics of Classical Conditioning (Pavlov), the process of Extinction, Discrimination and Generalization. Operant Conditioning (Skinner expt). The basics of operant conditioning, Schedules of reinforcement. Cognitive – Social approaches to learning – Latent Learning, Observational Learning, Trial and Error Method, Insightful Learning.	
Experimental Psychology (Practicals)- Self Study 2 Hrs /Week	
1.Bhatia's Battery of Performance and intelligence test 2.Multidimensional Assessment of Personality 3.David's Battery of Differential Abilities (Aptitude test)	

4.Bilateral Transfer of Training Mirror drawing apparatus with Electronic Digital Reset Error Counter (Performance) 5. Student Stress Scale.

Course Outcomes: After completing the course, the students will be able to	
CO1	Describe the basic theories, principles, and concepts of applied psychology as they relate to behaviors and mental processes.
CO2	Define learning and compare and contrast the factors that cognitive, behavioral, and Humanistic theorists believe influence the learning process.
CO3	Develop understanding of psychological attributes such as intelligence, aptitude, creativity, resulting in their enhancement and apply effective strategies for self-management and self-improvement.
CO4	Apply the theories into their own and others' lives in order to better understand their personalities and experiences.
CO5	Understand the application of psychology in engineering and technology and develop a route to accomplish goals in their work environment.

Reference Books:
1. . Understanding Psychology Feldman R. S, IV edition, (1996) McGraw Hill India
2. Psychology Robert A. Baron, III edition (1995) Prentice Hall India.
3. Organizational Behaviour , Stephen P Robbins Pearson Education Publications, 13th Edition, ISBN – 81-317 – 1132 – 3
4. Organisational Behaviour : Human Behaviour at Work ,John W.Newstrem and Keith Davis. Tata McGraw Hill India, 10th Edition, ISBN 0-07-046504-5
5. Psychology-themes and variations , Wayne Weiten, IV edition, Brooks / Cole Publishing Co.

Scheme of Continuous Internal Evaluation (CIE):
CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for assignment is 10. The total marks of CIE are 100. **Total CIE is 30(Q) +60(T) +10(A) =100 Marks.**

Scheme of Semester End Examination (SEE):
SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

VII Semester						
FOUNDATIONAL COURSE ON ENTREPRENEURSHIP (Group : Global Elective)						
Course Code	**:**	**16G7H16**		**CIE Marks**	**:**	**100**
Credits: L:T:P:S	**:**	**3:0:0:0**		**SEE Marks**	**:**	**100**
Total Hours	**:**	**36L**		**SEE Duration**	**:**	**03 Hours**

Course Learning Objectives:	
1	To make participants self-discover their innate flow, entrepreneurial style, and identify problems worth solving thereby becoming entrepreneurs
2	To handhold participants on lean methodology to craft value proposition and get ready with lean canvas
3	To create solution demo by conducting customer interviews and finding problem-solution fit for building Minimum Viable Product (MVP)
4	To make participants understand cost structure, pricing, revenue types and importance of adopting shared leadership to build good team
5	To help participants build a strong brand and identify various sales channels for their products and services
6	To take participants through basics of business regulations and other legal terms along-with understanding of Intellectual Property Rights

Unit-I	**07 Hrs**
Self Discovery and Opportunity Discovery Finding the Flow; Effectuation; Identifying the Effectuation principles used in activities; Identifying Problem Worth Solving; Design Thinking; Brainstorming; Presenting the Identified problems; Identifying the Entrepreneurial Style.	
Unit – II	**07 Hrs**
Customer, Solution and Lean Methodology Customers and Markets; Segmentation and Targeting; Identifying Jobs, Pains, and Gains and Early Adopters; Crafting Value Proposition Canvas (VPC); Presenting VPC; Basics of Business Model and Lean Approach; Sketching the Lean Canvas; Risks and Assumptions; Presenting Lean Canvas.	
Unit – III	**07 Hrs**
Problem-Solution Fit and Building MVP Blue Ocean Strategy - Plotting the Strategy Canvas; Four Action Framework: Eliminate-Reduce-Raise-Create Grid of Blue Ocean Strategy; Building Solution Demo and Conducting Solution Interviews; Problem-Solution Fit; Building MVP; Product-Market Fit; Presenting MVP.	
Unit – IV	**06 Hrs**
Financial Planning & Team Building Cost Structure - Estimating Costs; Revenues and Pricing: Revenue Streams, Revenue Types, Identifying Secondary Revenue Streams, Estimating Revenue and Price; Profitability Checks; Bootstrapping and Initial Financing; Practising Pitch; Shared Leadership; Hiring and Fitment, Team Role and Responsibilities.	
Unit – V	**09 Hrs**
Marketing, Sales, Regulations and Intellectual Property Positioning and Branding; Channels; Sales Planning; Project Management; Basics of Business Regulations; How to Get Help to Get Started; Patents, Trademark, Licensing, Contracts; Common Legal mistakes, Types of Permits, Tax Registration Documents, Compliance; Infringement and Remedies, Ownership and Transfer.	

Course Outcomes: After completing the course, the students will be able to	
CO1	showcase the ability to discern distinct entrepreneurial traits
CO2	Know the parameters to assess opportunities and constraints for new business ideas
CO3	Understand the systematic process to select and screen a business idea
CO4	design strategies for successful implementation of ideas
CO5	Create Business Model and develop Minimum Viable Product

Reference Books	
1	Running Lean: Iterate from Plan A to a Plan That Works. O'Reilly Media, Maurya, A., 2012.
2	Entrepreneurship.Roy, R., 2012. Oxford University Press
3	Intellectual Property Law in India. Gupta, T. S., 2011. Kluwer Law International
4	Flow: The Psychology of Optimal Experience. Czikszentmihalyi, M., 2008. Harper Perennial Modern Classics
5	Effectuation: Elements of Entrepreneurial Expertise. Sarasvathy, S. D., 2009. Edward Elgar Publishing Ltd.

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for assignment is 10. The total marks of CIE are 100.
Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)- (Needs to be discussed)
SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Semester: VII						
UNMANNED AERIAL VEHICLES (Group H: Global Elective)						
Course Code	**:**	**16G7H17**		**CIE**	**:**	**100 Marks**
Credits: L:T:P:S	**:**	**3:0:0:0**		**SEE**	**:**	**100 Marks**
Hours	**:**	**36L**		**SEE Duration:**	**:**	**3Hrs**

Course Learning Objectives: The students will be able to	
1	Get an overview of the history of UAV systems
2	Understand the importance of aerodynamics, propulsion, structures and avionics in the design of UAV
3	Demonstrate ability to address the various mission payloads - on-board & off-board, propulsion systems, integration with manned systems
4	Assess the performance and airworthiness of the designed UAV

Unit-I	**06 Hrs**
Introduction to Flight Vehicles: History of Flight Vehicles and UAVs, Classifications, Woking principles of flight vehicle. **Introduction to Unmanned Aircraft Systems** Types of UAVs, configurations and their advantages disadvantages, System Composition, Applications of UAVs, Characteristics of Aircraft	
Unit – II	**07 Hrs**
Design of UAV Systems: Governing aspects: **a. Aerodynamics, b. Propulsion, C. structure, d. Controls** **Aerodynamics:** Introduction basic Aerodynamics, lift, drag, Aerofoils, wing area optimization. **Propulsion:** Introduction to propulsion system in UAV, Propulsion system for fixed wing UAV and VTOL (Vertical take-off and landing) UAV, Advanced propulsion systems, fuel cells, generators based systems.	
Unit -III	**07Hrs**
Structures of UAV: Mechanic loading, basics of types of load calculation and structural engineering, Material used for UAV (general introduction), FRP and methods of usage in UAV, Testing of FRP specimens for UAV, selection criteria for structure, Types of structural elements used in UAV their significance and characteristics, Methods of manufacturing UAV structure.	
Unit -IV	**07 Hrs**
Controls, Avionics, Hardware, Communication, Payloads: Basics of control system and Systems for control system in UAV, PID control, simulation introduction to Hardware in loop system (HILS), Avionics: Autopilot (AP) – architecture of AP, sensors, actuators, power supply, integration, installation, configuration, and testing. **Hardware, Communication** Electronics Hardware in UAV, Communication methods, communication antenna and their significance. **Payloads:** Payload types and their applications	
Unit -V	**09 Hrs**
Design of UAV Systems: Fixed wing UAV and Rotary wing UAV (VTOL) Task specific, activity based exercise	

Course Outcomes: At the end of this course the student will be able to :	
CO1	Appraise the evolution of UAVs and understand the current potential benefits of UAVs
CO2	Apply the principles of Aerospace Engineering in design and development of UAVs
CO3	Determine and evaluate the performance of UAV designed for various Missions and applications
CO4	Assess the performance and airworthiness of the designed UAV

Reference Books	
1	Unmanned Aircraft Systems UAV design, development and deployment, Reg Austin, 1st Edition, 2010, Wiley, ISBN 9780470058190.
2	Flight Stability and Automatic Control, Robert C. Nelson, 2nd Edition, October 1, 1997, McGraw-Hill, Inc, ISBN 978-0070462731.
3	Advances in Unmanned Aerial Vehicles: State of the Art and the Road to Autonomy, Kimon P. Valavanis, 1st Edition,2007, Springer ISBN 9781402061141
4	Introduction to UAV Systems, Paul G Fahlstrom, Thomas J Gleason, 4th Edition, 2012, Wiley, ISBN: 978-1-119-97866-4
5	Design of Unmanned Air Vehicle Systems, Dr. Armand J. Chaput, 3rd Edition, 2001, Lockheed Martin Aeronautics Company, ISBN: 978-1-60086-843-6

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60.The marks component for Assignment/Presentation/Project 10.

Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**3**	**3**	**1**	**1**	**3**	**2**	**2**				**1**
CO2	**2**	**3**	**3**	**3**	**1**	**1**	**1**	**1**				**2**
CO3	**1**		**3**	**3**								**2**
CO4	**3**	**3**	**3**	**3**		**2**	**1**	**2**				**2**

High-3 : Medium-2 : Low-1

Semester VIII			
Major Project (Common to all Programs)			
Course Code : 16CS81		**CIE : 100 Marks**	
Credits: L:T:P:S : 0:0:16:0		**SEE : 100 Marks**	
Hrs/week : 32		**SEE Duration : 3.00 Hours**	
Course Learning Objectives: The students will be able to			
1	Acquire the ability to make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task.		
2	Acquire the skills to communicate effectively and to present ideas clearly and coherently to a specific audience in both written and oral forms.		
3	Acquire collaborative skills through working in a team to achieve common goals.		
4	Self-learn, reflect on their learning and take appropriate action to improve it.		
5	Prepare schedules and budgets and keep track of the progress and expenditure.		

Major Project Guidelines:

1. The project topic, title and synopsis have to be finalized and submitted to their respective internal guide(s) before the beginning of the 8th semester.
2. The detailed Synopsis (approved by the department ***Project Review Committee***) has to be submitted during the 1st week after the commencement of 8th semester.

Batch Formation:

- Students are free to choose their project partners from within the program or any other program;
- Each student in the team must contribute towards the successful completion of the project. The project may be carried out In-house / Industry / R & D Institution;
- ***The project work is to be carried out by a team of two to four students , in exceptional cases where a student is placed in a company and offered an internship through the competitive process or student is selected for internship at national or international level through competitive process*****,** the student can work independently.
- ***The students are allowed to do either a project for full 5 days in the industry or full 5 days in the college.***
- ***In case the project work is carried out outside Bengaluru, such students must be available during Project Evaluation process scheduled by the respective departments and they must also interact with their guide regularly through Email / Webinar / Skype etc.***

Project Topic Selection:

The topics of the project work must be in the *field of respective program areas or in line with CoE's (Centre of Excellence) identified by the college* or List of project areas as given by industry/Faculty. The projects as far as possible should have societal relevance with focus on sustainability.

Project Evaluation:

- Continuous monitoring of project work will be carried out and cumulative evaluation will be done.
- The students are required to meet their internal guides once in a week to report their progress in project work.
- **Weekly Activity Report** (WAR) has to be maintained in the form of a diary by the project batch and the same has to be discussed with the Internal Guide regularly.
- In case of ***Industry project***, during the course of project work, the internal guides will have continuous interaction with external guides and will visit the industry at least twice during the project period.

- For CIE assessment the project groups must give a final seminar with the draft copy of the project report.
- The presentation by each group will be for 20-30 minutes and every member of the team needs to justify the contributions to the project.
- The project team is required to submit Hard copies of the detailed Project Report in the prescribed format to the department.
- For CIE 50% weightage should be given to the project guide and 50% weightage to the project evaluation committee.
- Before the final evaluations the project group is required to produce a No dues certificate from Industry, Central Library and Department.

Course Outcomes of Major Project:	
1	Apply knowledge of mathematics, science and engineering to solve respective engineering domain problems.
2	Design, develop, present and document innovative/multidisciplinary modules for a complete engineering system.
3	Use modern engineering tools, software and equipment to solve problem and engage in life-long learning to follow technological developments.
4	Function effectively as an individual, or leader in diverse teams, with the understanding of professional ethics and responsibilities.

CIE Assessment:

The following are the weightings given for the various stages of the project.

1. Selection of the topic and formulation of objectives 10%
2. Design and Development of Project methodology 25%
3. Execution of Project 25%
4. Presentation, Demonstration and Results Discussion 30%
5. Report Writing & Publication 10%

SEE Assessment:

The following are the weightages given during Viva Examination.

1. Written presentation of synopsis 10%
2. Presentation/Demonstration of the project 30%
3. Methodology and Experimental Results & Discussion 30%
4. Report 10%
5. Viva Voce 20%

Calendar of Events for the Project Work:

Week	Event
Beginning of 7th Semester	Formation of group and approval by the department committee.
7th Semester	Problem selection and literature survey
Last two weeks of 7th Semester	Finalization of project and guide allotment
II Week of 8th Semester	Synopsis submission and preliminary seminar
III Week	First visit of the internal guides to industry (In case of project being carried out in industry)
III to VI Week	Design and development of project methodology
VII to IX Week	Implementation of the project
X Week	Submission of draft copy of the project report
XI and XII Week	Second visit by guide to industry for demonstration. Final seminar by Department project Committee and guide for internal assessment. Finalization of CIE.

Evaluation Scheme for CIE and SEE

Scheme of Evaluation for CIE		**Scheme of Evaluation for SEE**	
Particulars	**%Marks**	**Particulars**	**%Marks**
Project Evaluation I	10%	Project Synopsis (Initial Write up)	10%
Project Evaluation II	25%	Project Demo / Presentation	30%
Project Evaluation III	25%	Methodology and Results Discussion	30%
Project Evaluation Phase-IV (Submission of Draft Project Report for Verification**)**	30%	Project Work Report	10%
Project Evaluation Phase-V (Project Final Internal Evaluation**)**	10%	Viva-voce	20%
Total	100	Total	100

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**3**	**3**	**3**	**2**	**2**	**1**	**2**	**2**	**2**	**2**	**2**
CO2	**3**	**3**	**3**	**3**	**2**	**2**	**1**	**2**	**2**	**2**	**2**	**2**
CO3	**3**	**3**	**3**	**3**	**2**	**2**	**1**	**2**	**2**	**2**	**2**	**2**
CO4	**1**	**1**	**11**	**1**	**1**	**1**	**1**	**2**	**1**	**2**	**1**	**1**

High-3 : Medium-2 : Low-1

Semester VIII						
Technical Seminar (Common to all Programs)						
Course Code	**:**	**16CS82**		**CIE**	**:**	**100 Marks**
Credits: L: T: P: S	**:**	**0:0:2:0**		**SEE**	**:**	**100 Marks**
Hrs/week	**:**	**04**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to	
1	Recognize recent developments in specific program and in multidisciplinary fields.
2	Summarize the recent technologies and inculcate the skills for literature survey.
3	Demonstrate good presentation skills.
4	Plan and improve the Technical Report writing skills.
5	Support Group discussion and Team work.

General Guidelines for the Seminar

1. The seminar has to be presented by individual student.
2. The topic of the seminar should be from current thrust area along with consultation with the guide.
3. The topic can be based on standard papers (like IEEE/ACM/CSI etc.) in the thrust area for the selected topic.
4. Presenting/publishing this paper in conference/ Journal will be given weightage in CIE.
5. The student needs to submit both hard & soft copy of the seminar report.
6. **As Outcome of Technical Seminar, each student has to prepare a technical paper out of seminar topic.**

Course Outcomes of Technical Seminar:	
1	Communicate effectively on complex engineering problems and demonstrate contextual knowledge to assess societal and environmental contexts.
2	Identify, formulate, review research literature, analyze and Design solutions for complex engineering problems using appropriate techniques with effective documentation.
3	Analyze, interpret and synthesize the information to provide valid conclusions with innovative ideas and ethical principles.
4	Apply the knowledge of engineering specialization to suggest solutions to complex engineering problems and recognize the need for technological changes.

Evaluation of CIE Marks:

1. Relevance of the topic 10%
2. Literature Survey 10%
3. Presentation 40%
4. Report 20%
5. Paper Publication 20%

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**-**	**1**	**1**	**-**	**-**	**1**	**-**	**2**	**-**	**-**	**-**	**2**
CO2	**2**	**1**	**2**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**2**	**2**
CO3	**-**	**2**	**1**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO4	**1**	**2**	**2**	**1**	**1**	**2**	**2**	**-**	**2**	**2**	**-**	**2**

High-3 : Medium-2 : Low-1

VIII Semester						
Innovation & Social Skills (Common to all Programs)						
Course Code	**:**	**16HS83**		**CIE**	**:**	**NA**
Credits: L: T: P: S	**:**	**0:0:1:0**		**SEE**	**:**	**NA**
Hrs/week	**:**	**02**		**SEE Duration**	**:**	**NA**

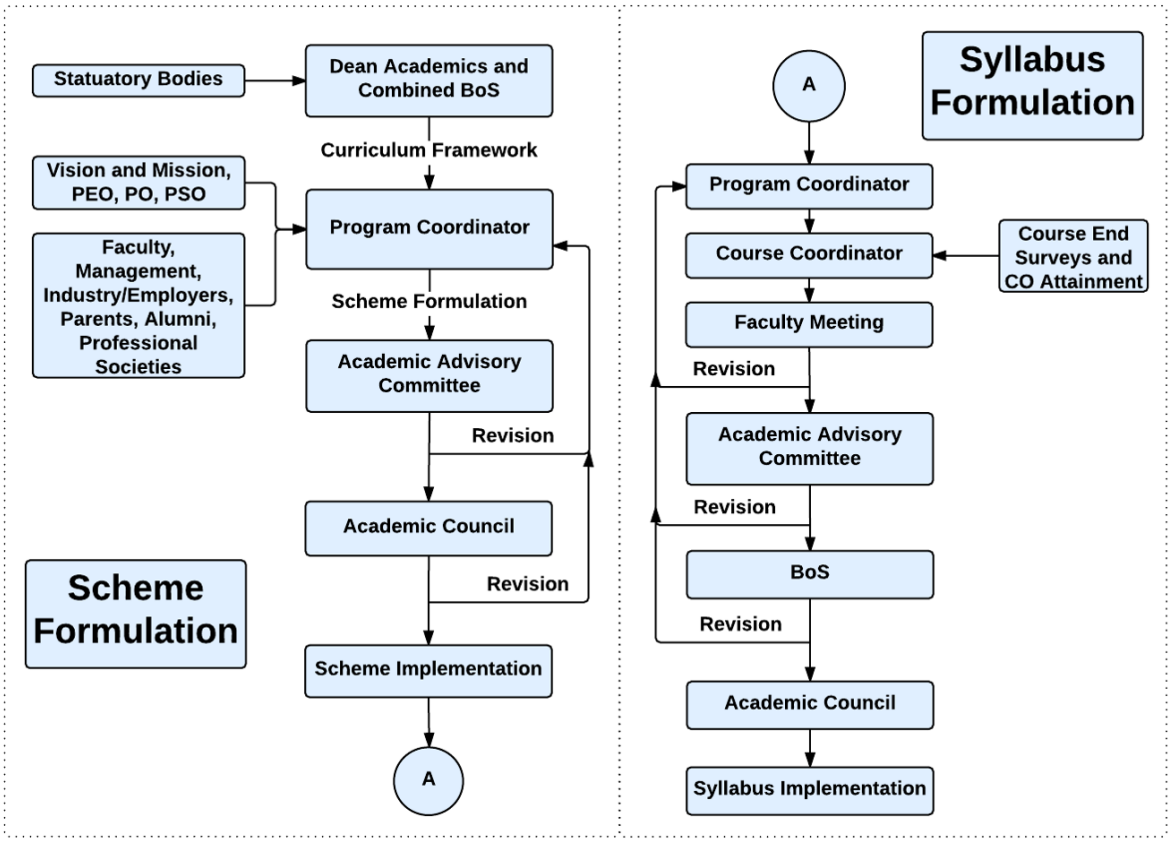
Course Learning Objectives: The students will be able to	
1	To provide a platform for the students to exhibit their organizational capabilities, team building, ethical values and extra mural abilities.
2	To encourage to carryout innovative ideas and projects.
3	Take part in societal and community building activities.
4	Make self-learning, ethics and lifelong learning a motto.

Guidelines

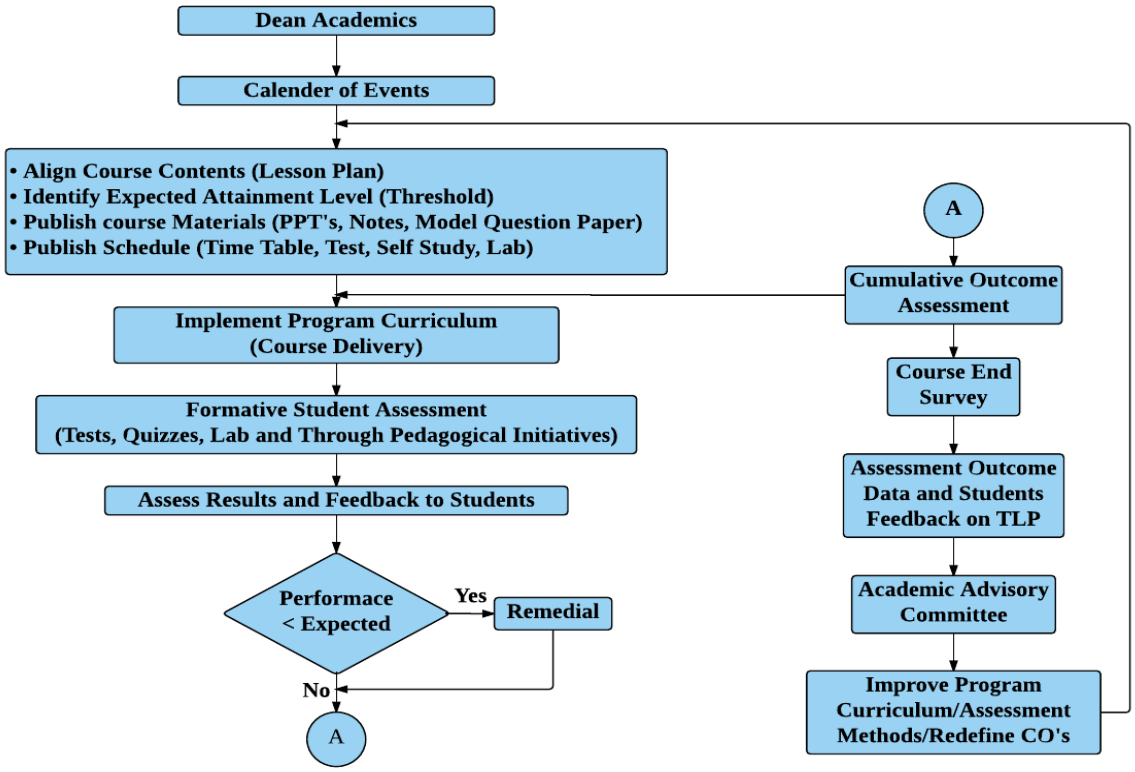
1. The HSS will be evaluated individually based on the broad parameters which include the progress made by student during 3rd& 4th year in innovative projects, Seminar, Paper Presentation, Field activity & other Co-curricular activities.
2. Students shall submit a report and documents as a proof his/her achievements.

Course Outcomes of Innovation & Social Skills:	
1	Apply the knowledge and skills for solving societal issues
2	Plan to work in team in various areas with inclusive effort and sustainability
3	Organize various events and use managerial and budgeting abilities
4	Demonstrate leadership qualities and ethics

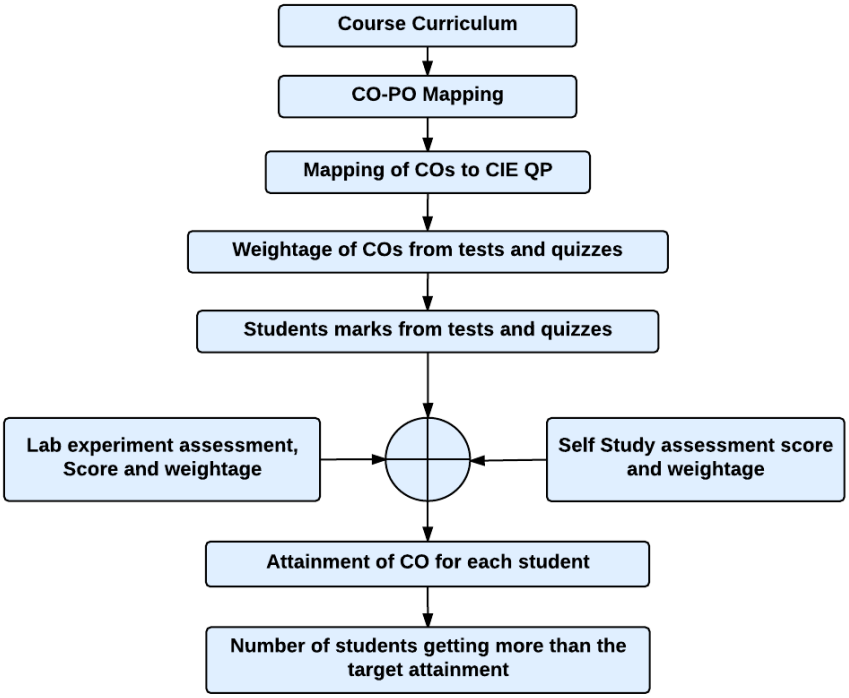
Curriculum Design Process



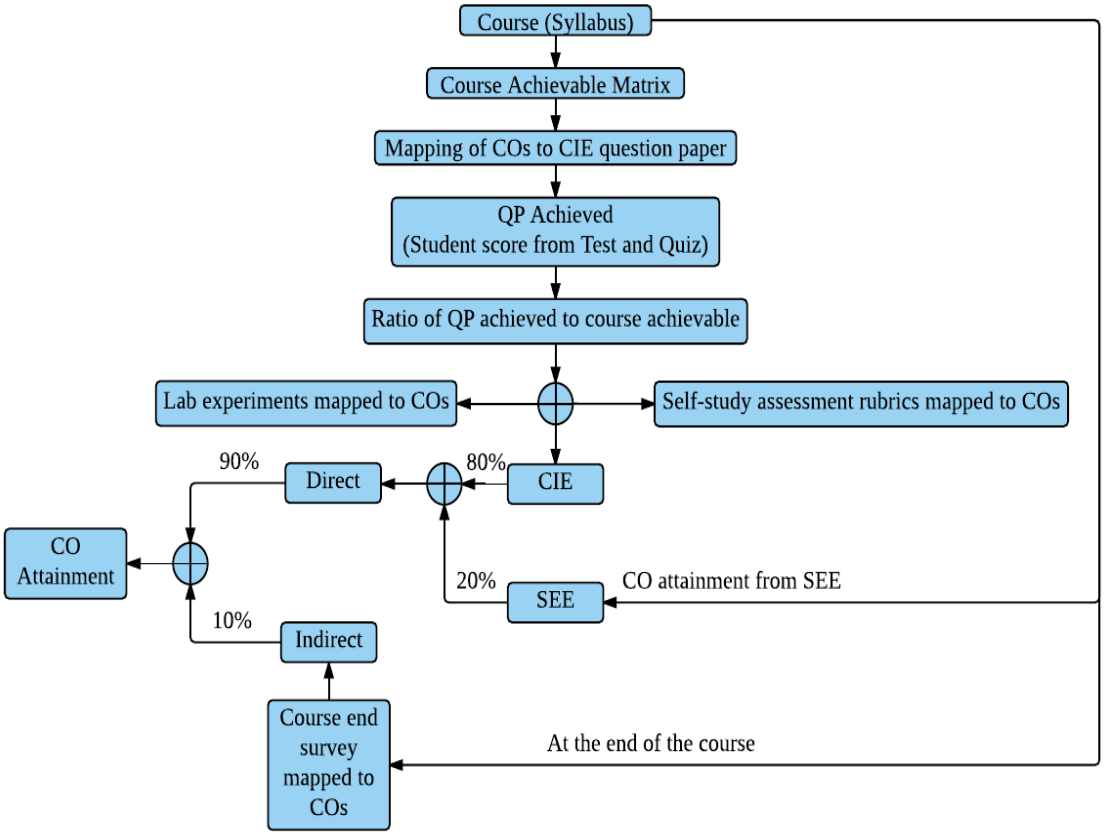
Academic Planning and Implementation


Dean Academics
Calender of Events
• Align Course Contents (Lesson Plan)
• Identify Expected Attainment Level (Threshold)
• Publish course Materials (PPT's, Notes, Model Question Paper)
• Publish Schedule (Time Table, Test, Self Study, Lab)
Implement Program Curriculum (Course Delivery)
Formative Student Assessment (Tests, Quizzes, Lab and Through Pedagogical Initiatives)
Assess Results and Feedback to Students
Performace < Expected
Yes
Remedial
No
A
A
Cumulative Outcome Assessment
Course End Survey
Assessment Outcome Data and Students Feedback on TLP
Academic Advisory Committee
Improve Program Curriculum/Assessment Methods/Redefine CO's

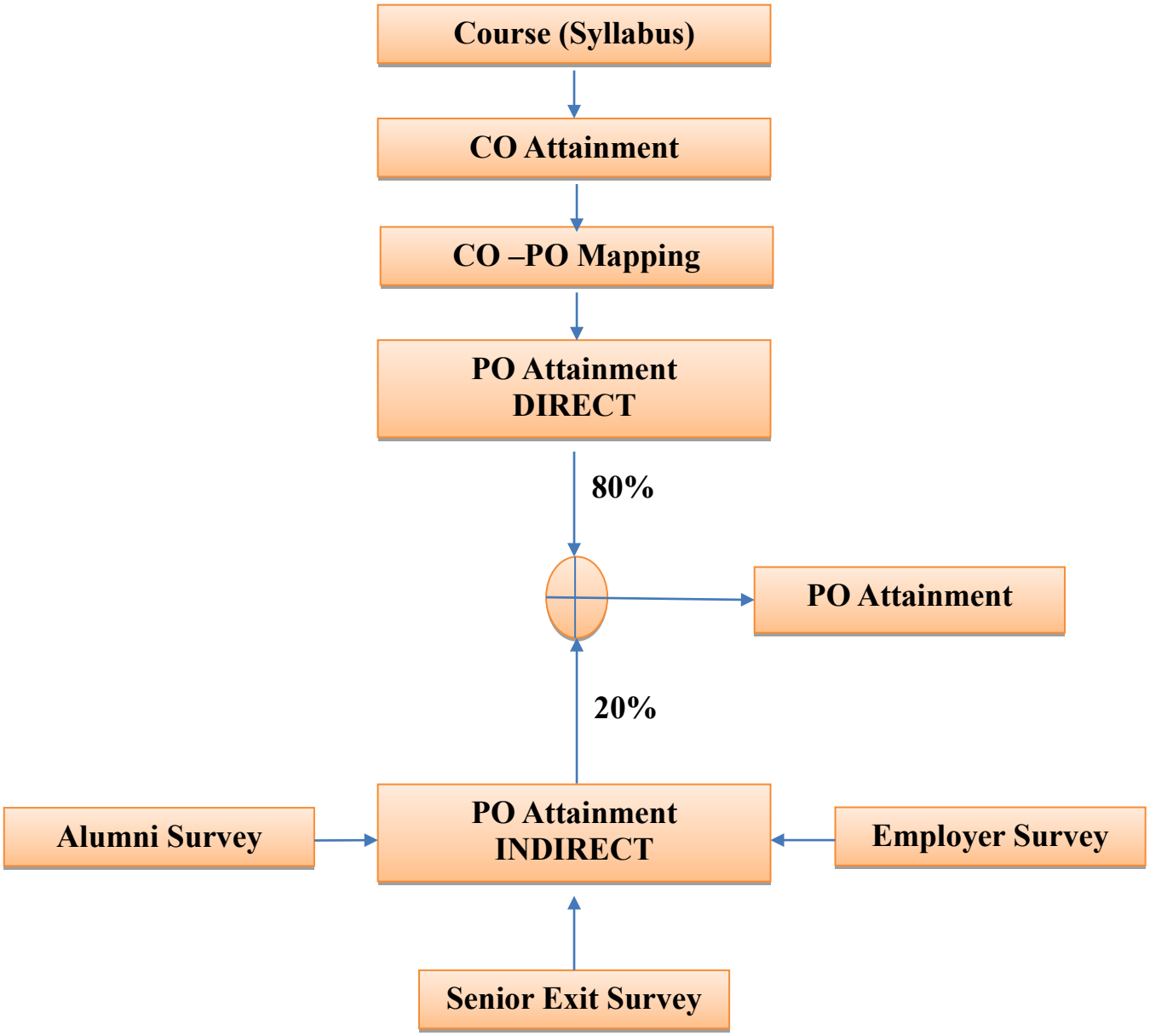
PROCESS FOR COURSE OUTCOME ATTAINMENT



Final CO Attainment Process



Program Outcome Attainment Process



Guidelines for Fixing Targets

- The target may be fixed based on last 3 years' average attainment

PROGRAM OUTCOMES (POs)

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation for the solution of complex engineering problems.

2. **Problem analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet t h e specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling to complex engineering activities, with an understanding of the limitations.

6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with t h e society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **Life-long learning:** Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.