BharatiyaVidyaBhavan's

Sardar Patel Institute of Technology

(Autonomous Institute Affiliated to University of Mumbai)

Revision: SPIT-4-19

Bachelor of Engineering/Technology (B.E./B.Tech)
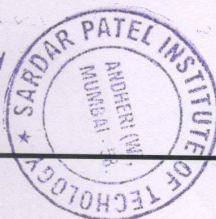# in
Information Technology

Final Year Engineering
(Sem. VII and Sem. VIII)
Effective from Academic Year 2019– 2020

Board of Studies Approval: 11/12/2018

Academic Council Approval: 16/01/2019

Principal
Sardar Patel Institute of Technology
Bhavans Andheri Campus
Munshi Nagar, Andheri (West).
Mumbai 400 058.

Choice Based Internship Policy Details

Category '1':

Students who want to **register for placement and interested in joining semester long internship** will have following procedure

1. They will follow the regular placement procedure during their 7th Semester

2. They will proceed for internship in the company in which they have been selected from the next January.

3. Their credit requirements of 8th semester will be completed at the end of the **'summer term'** of their semester 6th.

4. The semester long internship will have credits assigned to it with appropriate evaluation mechanism.

5. The detail credit structure for semester 8th of category '1' will be declared in their next term in Jan 2019.

Category '2':

Students who do not want semester long internship (i.e. would want to continue with their **higher education immediately** after their B. Tech. /B.E. program).

1. The normal semester 7th and 8th will be working for them as per their regular academic calendar

2. The detail credit structure for semester 8 of category '2' will be declared in their next term in Jan 2019.

3. Students will be allowed to participate for the placement in normal company.

Choice of Category '1' or '2' shall be taken from the students in the mid of SEM VI.

Category '1': Student chooses for institute offered internship:

In this case student attends 'Summer Term' of 6 weeks duration.

Internship should be done by the student from 15th January to 30th June.

All the courses shall run twice a week during 'Summer Term'. Thus 1 hour lecture should be conducted for 12 hours in a summer term to get 1 credit.

ESE for summer term open elective courses shall be conducted in first and second week of July.

Make-up Examination for open elective courses shall be conducted along with SEM VI Make-up Examination.

Category '2': Student opt out of 'Institute offered company internship'

Student attends normal regular semesters as per institute calendar

SEM VIII students will attend OE courses along with SEM VI students.

Student appears for regular ESE examination.

Make-up Examination shall be conducted in first and second week of July.

Internship Related Other Guidelines:

1. Once a particular 'Category' is selected by the student then he/she will **NOT be allowed to change the category** for whatsoever reason.

2. If performance of the student is reported as poor by the industry or industry raises concerns about attendance issues of student during the internship then student may be called back to the institute. In this case he/she will have to complete the coursework equivalent to internship credits. If institute runs 'summer term' then student can take courses (two theory courses and two labs) in summer term. Otherwise student will have to take courses (two theory courses and two labs) in the ODD semester of the next academic year. In this case student will be allowed to sit for the placement after rejoining the institute.

3. Internships will be given by the S.P.I.T. as per the selection criteria of company. Following are the other avenues for internships:

    a. SPTBI

    b. Reputed organizations like IIT, BARC, TIFR etc.with condition that the organization selected is ready to do the assessment for 10 credits of   internship

    c. If student get an internship offer on his own in a particular company then he/she needs to connect company.

4. For all internships, S.P.I.T. approval is must and there should be a grade penalty for students accepting internship and not joining a company or joining a company but not completing internship

MOOC courses can be taken any time during the entire academic year. However MOOC* credits will be added to semester VIII as and when 'pass' certificate is submitted by the student.

List of MOOC courses will be curated by the department and students need to select from the list. If student wish to have course which is not present in the list then written approval from Head of Department and Dean Academics is necessary.

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Information Technology Department

Semester VII common to both category '1' and category '2'

SEM VII						
Course Code	**Course Name**	**Group**	**Teaching Scheme (Hrs/week)**			**Credits**
			L	**T**	**P**	**Total**
IT71	Digital Image Processing	PC	3	--	--	3
ITE71^	Elective-I	PE	3	--	--	3
ITE72^	Elective-II	PE	3	--	--	3
ITL71	Digital Image Processing lab	PC	--	--	2	1
ITEL71^	Elective-I Lab	PE	--	--	2	1
ITEL72^	Elective-II Lab	PE	--	--	2	1
ITP71	Category-'1': Major Project-II Category-'2': Major Project-I	PR	--	--	10#	5
CEP5	Problem solving module-V (Optional)	CEP				
	Total		**9**	**--**	**16**	**17**

ITE71^	A. Data Analytics B. Ad-hoc and Wireless Sensor Network C. AI and Expert System
ITE72^	A. Soft computing B. Cloud Computing C. IT Infrastructure Management

Summer Term for Category '1': Student chooses for semester long internship

Summer Term						
Course Code	**Course Name**	**Group**	**Teaching Scheme (Hrs/week)**			**Credits**
HSS81	Technology Entrepreneurship Lab	HSS	--	--	2	1
OE^	Open Elective @	OE	1@	--	2@	2@
OE^	Open Elective @	OE	1@	--	2@	2@
ITP81	Category-'1': Major Project-I	PR	--	--	10	5
MOOC	MOOC (Min 8 week course)	MOOC	--	--	--	2
INT	Internship	PR	--	--	--	10#
ABL5	Financial Planning, Taxation Policies and Investment (Noncredit)	--	--	--	--	--
	Total		2	--	12+4@	8+4@+10#

Semester VIII for Category '2': **Students opt out of 'Semester Long Internship'**

SEM VIII						
Course Code	Course Name	Group	Teaching Scheme (Hrs/week)			Credits
HSS81	Technology Entrepreneurship Lab	HSS	--	--	2	1
OE^	Open Elective @	OE	1@	--	2@	2@
OE^	Open Elective @	OE	1@	--	2@	2@
ITP81	Category-'2': Major Project-II	PR	--	--	10	5
MOOC	MOOC (Min 8 week course)	MOOC	--	--	--	2
ABL5	Financial Planning, Taxation Policies and Investment (Noncredit)	--	--	--	--	--
IT81	Enterprise Resource Planning	PC	3	1	--	4
IT82	UX Design	PC	3	1	--	4
ITL81	Enterprise Resource Planning lab	PC	--	--	2	1
ITL82	UX Design lab	PC	--	--	2	1
	Total		6+2@	2	16+4@	18+4@

List of Open Elective Courses:

OE1: Consumer Electronics (ETRX)

OE2: Robotic Vision (ETRX)

OE3: Cyber Security and Digital Forensics (EXTC)

OE4: Internet of Things (EXTC)

OE5: Fundamentals of Computational Intelligence (COMP)

OE6: Fundamentals of Data Structures and Algorithms (COMP)

OE7: Software Testing (IT)

OE8: Database Management Systems (IT)

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Evaluation Scheme

B.E./B.Tech Information Technology (SEM VII)					
Course Code	**Course Name**	**Marks**			
		ISE	MSE	ESE	Total
IT71	Digital Image processing	20	20	60	100
ITE71^	Elective-I	20	20	60	100
ITE72^	Elective-II	20	20	60	100
ITL71	Digital Image processing lab	40	--	--	40
ITEL71^	Elective-I Lab	40	--	--	40
ITEL72^	Elective-II Lab	40	--	--	40
ITP71	Category-'1': Major Project-II Category-'2': Major Project-I	80&	--	20	100
CEP5	Problem solving module-V (Optional)	--	--	--	--
	Total				**520**
For Category '2': B.E./B.Tech Information Technology (SEM VIII)					
Course Code	**Course Name**	**Marks**			
		ISE	MSE	ESE	Total
HSS81	Technology Entrepreneurship Lab	40	--	--	40
OE^	Open Elective @	40	10	20	70
OE^	Open Elective @	40	10	20	70
ITP81	Category-'2': Major Project-II	80&	--	20	100
MOOC	MOOC (Min 8 week course)	--	--	--	100
ABL5	Financial Planning, Taxation Policies and Investment (Noncredit)	--	--	--	--
IT81	Enterprise Resource Planning	20	20	60	100
IT82	UX Design	20	20	60	100
ITL81	Enterprise Resource Planning lab	40	--	--	40
ITL82	UX Design lab	40	--	--	40
	Total				**660**

& Phase-I: 40   Phase-II: 40

SUMMER TERM: For Category '1': B.E. /B.Tech Information Technology (SEM VIII)					
Course Code	**Course Name**	**Marks**			
		ISE	MSE	ESE	Total
HSS81	Technology Entrepreneurship Lab	40	--	--	40
OE^	Open Elective @	40	10	20	70
OE^	Open Elective @	40	10	20	70
ITP81	Category-'1': Major Project-I	80&	--	20	100
MOOC	MOOC (Min 8 week course)	--	--	--	100
ABL5	Financial Planning, Taxation Policies and Investment (Noncredit)	--	--	--	--
INT	Internship	--	--	--	*280
	Total				**660**

* Kindly refer internship evaluation guidelines for 280 marks

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Monitoring & Evaluation of Internship

Course Name: Internship Course Code: INT	MSE	ESE	Total Marks	Total Credits
Institute Supervisor Evaluation	70	70	140	05
Industry Mentor Evaluation	70	70	140	05
	140	140	280	10

For MSE and ESE: **60 Marks Rubrics Based Evaluation**
10 Marks Internship Report Evaluation

Parameters for Rubrics Based Evaluation of Intern

(Needs improvement=1; Satisfactory=2; Good=3; Excellent=4)

S.N.	Parameters	Scale (1 to 4)
1	Behaviors	
2	Performs in a dependable manner	
3	Cooperates with co-workers and supervisors	
4	Shows interest in work Learns quickly	
5	Shows initiative	
6	Accepts responsibility	
7	Accepts criticism	
8	Demonstrates organizational skills	
9	Shows good judgment	
10	Analyzes problems effectively	
11	Is self-reliant	
12	Communicates well	
13	Has a professional attitude and appearance	
14	Is punctual	
15	Uses time effectively	
Rate the following parameters for Internship Report **(Needs improvement=1; Satisfactory=1.5; Good=2; Excellent=2.5)**		
17	Writes effectively	
18	Uses technical knowledge and expertise	
19	Demonstrates creativity/originality	
20	Produces high quality work	
	Total (Out of 70)	

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
IT71	**Digital Image Processing**	3	--	--	3	--	--	3
		Examination Scheme						
		ISE		MSE		ESE		Total
		20		20		60		100

Pre-requisite Course Codes		
After successful completion of the course, student will be able to		
Course Outcomes	COIT71.1	Evaluate the techniques for enhancing and segmenting Images.
	COIT71.2	Analyze images using various transforms.
	COIT71.3	Categorize and interpret various compression techniques and standards.
	COIT71.4	Apply image processing algorithms in practical applications.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction**		
	1.1	Light, Brightness adaption and discrimination	2	
	1.2	Pixels, Coordinate conventions, Imaging Geometry	1	04
	1.3	Sampling and quantization	2	
	1.4	Fundamental steps in digital Image Processing	1	
2		**Image enhancement in the spatial domain**		
	2.1	Point operations	1,2	
	2.2	Histogram processing	1,2	
	2.2.1	Histogram Stretching	1,2	
	2.2.2	Histogram equalization	1,2	07
	2.2.3	Histogram Specification	1,2	
	2.3	Spatial filtering: smoothing	1	
	2.4	Sharpening	1	
3		**Image Transforms**		
	3.1	Discrete Fourier Transforms and properties	1,2	
	3.2	FFT (Decimation in Frequency and Decimation in Time Techniques)	1,2	07
	3.3	Convolution	1,2	
	3.4	Hadamard-Walsh Transform	1,2	
	3.5	Discrete Cosine Transform	1,2	
4		**Image Segmentation**		
	4.1	Detection of discontinuities	1	
	4.2	Edge linking and Boundary detection	1	06
	4.3	Hough transform	1	
	4.4	Thresholding	1	
	4.5	Region oriented segmentation.	1	

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5		**Image Compression**		
	5.1	Types of redundancies	**1,2**	
	5.2	Lossy and Lossless compression	**1,2**	
	5.3	Huffman Coding	**1,2**	
	5.4	Arithmetic Coding	**1,2**	**08**
	5.5	LZW/LZ77 coding	**1,2**	
	5.6	JPEG	**1,2**	
	5.7	Predictive coding	**1,2**	
	5.8	Motion Compensation	**1,2**	
6		**Morphological Image Processing**		
	6.1	Basics, Structuring Element	**1**	
	6.2	Erosion & Dilation	**1**	
	6.3	Opening & Closing	**1**	
	6.4	Hit-or-Miss Transform	**1**	**06**
	6.5	Boundary Detection	**1**	
	6.6	Hole filling	**1**	
	6.7	Thinning & thickening	**1**	
	6.8	Skeletons & pruning.	**1**	
7		**Applications of Image Processing**		
	7.1	Image processing in Health Care	**1,2**	
	7.2	Image Processing for Authentication	**1,2**	**04**
	7.3	Image Processing for Security	**1,2**	
	7.4	Content Based Image Retrieval	**1,2**	
			Total	**42**

Recommended Books:

1) Gonzalez and Woods, "*Digital Image Processing*", 4th Edition, Pearson Education, 2018.
2) Jain A. K., "*Fundamentals of Digital Image Processing*", Pearson Education, 2015.

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
ITE71A	Data Analytics	3	--	--	3	--	--	3
		Examination Scheme						
		ISE		MSE		ESE		Total
		20		20		60		100

Pre-requisite Course Codes	IT62 : Data Warehousing and Mining ITL64 : Machine Learning Lab BS41 : Applied Mathematics-II	
Course Outcomes	COITE71A.1	Choose appropriate storage structure to make sense out of data sets.
	COITE71A.2	Apply rules and theorems in statistics to analyze the data.
	COITE71A.3	Analyze the key issues in big data management and its associated applications in intelligent business and scientific computing
	COITE71A.4	Apply different algorithms like page ranking, mining, clustering, finding similar items to get insights of the data.

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1.1	**Memory-efficient data structures** Hash functions, universal / perfect hash families, Bloom filters, Sketches for distinct count, Misra-Griessketch. Count Sketch, Count-Min Sketch , kd-trees, LSH, MinHash, SimHash	6	09
2	2.1	**Role of statistics and Probability** Linear Algebra- linear equations, distance, hyper planes, sampling statistics, Hypothesis testing, statistical modeling, multivariate optimization for data analytics	1,2,4,5	10
	2.2	**Hypothesis Testing** Normality Tests, t-tests, Analysis of Variance(Parametric & Non(ANOVA), One way ANOVA, Main Effect Parametric Tests) ANOVA, Factorial ANOVA, Repeated Measure ANOVA, ANCOVA and POST HOC test. Chisquare Test, F test, Sign Test, Mann-Whitney U Test, Chi-Square Test, Cochran Q Test Wald-Wolfowitz Runs Test, Kolmogorov-Smirnov Two-Sample Test Kruskal-Wallis ANOVA & Median Test, Wilcoxon Matched Pairs Test		

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3	3.1	**Scaling with Big Data using Hadoop** Big Data characteristics, types of Big Data, Traditional vs. Big Data business approach, data in Hadoop, MapReduce and Hadoop Ecosystem architecture	**3**	**12**
	3.2	**Scaling with Big Data using Apache SPARK** SPARK Eco system, SPARK streaming, Distributed Batch Processing with Spark	**7**	
4	4.1	**Link Analysis** PageRank, Efficient Computation of PageRank, Topic-Sensitive PageRank, Link Spam, Hubs and Authorities	**3**	**3**
	4.2	**MINING DATA STREAMS** Sampling data in a stream, Filtering streams, Analysis, Counting distinct elements in a stream, The Flajolet-Martin Algorithm	**3**	**3**
	4.3	**FREQUENT ITEMSETS AND CLUSTERING** Handling large data sets in Main memory, A-Priori, PCY, Limited Pass algorithm, The Multi stage Algorithm, The Multi hash Algorithm, SON algorithm, Counting frequent item sets in a stream, Clustering Techniques - Hierarchical ,K- Means, Clustering high dimensional data – CLIQUE and PROCLUS-CURE Algorithm, Counting Triangles, DGIM algorithm	**3**	**5**
		Total		**42**

Recommended Books:

1) Sheldon M. Ross, "*Introduction to Probability and Statistics for Engineers and Scientists*", 3rd Edition (Indian), Elsevier, New Delhi.
2) Davy Cielen, Meysman, Mohamed Ali, "*Introducing Data Science*", Dreamtech Press.
3) Anand Rajaraman, Jeffrey D. Ullman "*Mining of Massive Datasets*", 2nd Edition, Cambridge University Press.
4) Ajit C. Tamhane, Dorothy D. Dunlop, "*Statistics and data analysis : from elementary to intermediate*", Upper Saddle River, NJ : Prentice Hall, [2000]
5) Montgomery, Douglas C., and George C. Runger, "*Applied statistics and probability for engineers*", John Wiley & Sons, 2010.
6) Muthukrishnan. S. "*Data streams :Algorithms and applications. Foundations and Trends® in Theoretical Computer Science*", 1(2), 117-236, (2005).
7) Muhammad Asif Abbasi, "*Learning Apache Spark 2*", Packt Publishing, ISBN: 9781785885136, March 2017.

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
ITE71B	**Ad-hoc and Wireless Sensor Network**	3	-	-	3	-	-	3
		Examination Scheme						
		ISE		MSE		ESE		Total
		20		20		60		100

Pre-requisite Course Codes	IT52: Computer Networks
	ITL52: Computer Networks Lab

After successful completion of the course, student will be able to

Course Outcomes	ITE71B.1	Analyze different protocols for Wireless Ad-hoc Networks.
	ITE71B.2	Analyze different protocols for Wireless Sensor Networks.
	ITE71B.3	Identify challenges in designing various protocols for Wireless Ad-hoc Networks.
	ITE71B.4	Choose performance metrics for Wireless Sensor Networks.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Ad-hoc Wireless Networks**		
	1.1	Introduction		
	1.2	Ad-hoc Wireless Media Access Protocols- Problems in Ad-hoc Channel Access		
	1.3	Receiver- Initiated MAC Protocols, Sender- Initiated MAC Protocols	**3,4**	**8**
	1.4	Ad-hoc MAC Protocols- Multiple Access with Collision Avoidance (MACA), MACA-BI (By Invitation), Power-Aware Multi-Access Protocol with Signaling (PAMAS), Dual Busy Tone Multiple Access (DBTMA), MARCH: Media Access with Reduced Handshake.		
2		**Routing Protocols for Ad-hoc Networks**		
	2.1	Table Driven Routing Protocols- Destination Sequenced Distance Vector (DSDV)		
	2.2	Source-Initiated On-Demand Approaches- Ad-hoc On-Demand Distance Vector Routing (AODV), Dynamic Source Routing (DSR)	**3,4**	**7**
	2.3	Hybrid Routing Protocols- Zone Routing Protocol (ZRP)		
3		**TCP over Ad-hoc Wireless Networks**		
	3.1	TCP Flow Control, TCP Congestion Control, Issues with TCP		
	3.2	Versions of TCP	**3,4**	**6**
	3.3	Problems facing TCP in Wireless Ad-hoc		
	3.4	Approaches to TCP over Ad-hoc - TCP Feedback (TCP-F), TCP with Explicit Link Failure Notification, TCP-BuS		

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4		**Medium Access Control Protocol for Wireless Sensor Network**	**1,2,5**	**7**
	4.1	Fundamentals of MAC Protocols		
	4.2	MAC Protocols for WSNs		
	4.3	Sensor-MAC, EAR, The STEM,		
	4.4	Wireless Personal Area networks: Bluetooth (IEEE 802.15.1), ZigBee (IEEE 802.15.4)		
5		**Routing Protocols and Transport Control Protocols for Wireless Sensor Networks**	**1,2,5**	**9**
	5.1	Routing Challenges and Design Issues in WSNs		
	5.2	Routing Strategies in WSNs: WSN Routing Techniques, Flooding and its variants, Sensor Protocols for Information via Negotiation, Low-Energy Adaptive Clustering Hierarchy, Directed Diffusion, Geographical Routing,		
	5.3	Transport Control Protocols- CODA(Congestion Detection and Avoidance), ESRT (Event-to-Sink Reliable Transport)		
6		**Performance and Traffic Management**	**1**	**5**
	6.1	Performance Modeling of WSNs - Performance Metrics, Basic Models, Network Models		
	6.2	Case Study: Simple Computation of the System Life Span		
			Total	**42**

Recommended Books:

1) Kazem Sohraby, Daniel Minoli, Taieb Znati, "*Wireless Sensor Networks*", 1st Edition, Wiley Interscience, 2007.
2) Feng Zhao and Leonidas Guibas, "*Wireless Sensor Networks –An Information Processing Approach*", Elsevier Publications, 2004.
3) Siva Ram Murthy and B.S. Manoj, "*Ad Hoc Wireless Networks – Architectures and Protocols*", 2nd Edition, Pearson Education, 2005.
4) C. K. Toh, "*Ad hoc Mobile Wireless Networks – Protocols and Systems*", 1st Edition, Pearson Education, 2007.
5) Carlos de Morais Cordeiro, Dharma Prakash Agrawal, "*Ad Hoc And Sensor Networks: Theory And Applications*", 2nd Edition, World Scientific Publications, 2013.

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	**T**	**P**	**L**	**T**	**P**	**Total**
ITE71C	**AI and Expert System**	3	--	--	3	--	--	3
		Examination Scheme						
		ISE		**MSE**		**ESE**		**Total**
		20		20		60		100

Pre-requisite Course Codes	ITC31:Advanced Data Structures
	ITC41: Design and Analysis of Algorithms

After successful completion of the course, student will be able to

Course Outcomes	COITEL71C.1	Illustrate the building blocks of AI as presented in terms of intelligent agents
	COITEL71C.2	Choose an appropriate problem-solving method and knowledge-representation scheme for a given problem
	COITEL71C.3	Apply the appropriate search method on a given problem
	COITEL71C.4	Develop simple intelligent systems or classical toy problems using different AI techniques

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction to AI**		
	1.1	AI Problems and AI techniques	1	04
	1.2	Solving problems by searching		
	1.3	Problem Formulation.		
2		**Intelligent Agents**		
	2.1	Structure of Intelligent agents, Types of Agents,	1	03
	2.2	Agent Environments, PEAS representation for an Agent.		
3		**Uninformed Search Techniques**		
	3.1	DFS, BFS, Uniform cost search,	1, 2	05
	3.2	Depth Limited Search, Iterative Deepening, Bidirectional search, Comparing Different Techniques.		
4		**Informed Search Methods**		
	4.1	Best First Search, A*, IDA*, SMA*		
	4.2	Heuristic functions, Hill Climbing, Simulated Annealing	1, 2	10
	4.3	Crypto arithmetic Problem, Backtracking for CSP, Performance Evaluation		
	4.4	**Adversarial Search** Game Playing, Min-Max Search, Alpha Beta Pruning		
5		**Planning**		
	5.1	Introduction to planning		
	5.2	Representation of a planning problem	1, 3	04
	5.3	planning as state space search		
	5.4	Partial order planning, conditional planning		

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6		**Knowledge and Reasoning:**	**1, 4**	**08**
	6.1	A Knowledge Based Agent, WUMPUS WORLD Environment		
	6.2	Propositional Logic, First Order Predicate Logic,		
	6.3	Inferencing: Forward and Backward Chaining,		
	6.4	Resolution in Propositional Logic and First Order Logic, Introduction to PROLOG.		
7		**Introduction to Expert Systems**	**4, 5**	**05**
	7.1	Introduction, Difference between expert system and conventional programs		
	7.2	Expert systems - Architecture of expert systems, Roles of expert systems		
	7.3	Knowledge Acquisition –Meta knowledge, Heuristics. Expert systems shells.		
8		**Expert System Case Studies**	**4, 5**	**03**
	8.1	Basic aspect of Expert system		
	8.2	Typical expert systems - MYCIN, DART, XOON, etc.		
			Total	**42**

Recommended Books:

1) Stauart Russell and Peter Norvig, "*Artificial Intellingence: A Modern approach*", 3rd Edition Prentice Hall, New Jerset, 1995.
2) Elaine Rich and Kelvin Knight, "*Artificial Intelligence*", 3rd Edition Tata McGraw Hill, New Delhi, 1991.
3) Nilson N.J., "*Principles of Artificial Intelligence*", Springer Verlag, Berlin, 1980.
4) Patterson "*Introduction to Artificial Intelligence and Expert systems*", 1st Edition Prentice Hall of India, New Delhi, 1990.
5) Robert J shalkoff, "*Artificial Intelligence: An Engineering Approach*", 1st Edition McGraw Hill international Edition, 1990.

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
ITE72A	**Soft Computing**	3	-	-	3	-	-	3
		Examination Scheme						
		ISE		MSE		ESE		Total
		20		20		60		100

Pre-requisite Course Codes	ITL64: Machine Learning Laboratory
At the end of the course students will be able to	

	ITE72A.1	Illustrate the basic principles of soft computing techniques.
	ITE72A.2	Demonstrate the working of deep learning algorithms for neural networks.
Course Outcomes	ITE72A.3	Model Fuzzy Inference Systems.
	ITE72A.4	Make use of neural networks to solve different problems.
	ITE72A.5	Solve optimization problems using genetic algorithms.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction to Soft Computing**		
	1.1	What is Soft computing: Hard Computing vs. Soft Computing, Characteristics of Soft Computing	**1,2, 4,5, 9,10**	**5**
	1.2	Introduction to Neural Networks: Definition, Advantages, Applications, Scope.		
	1.3	Introduction to Fuzzy logic: Definition, Brief Review of Conventional Set Theory, Introduction to Fuzzy Sets, Applications.		
	1.4	Introduction to Genetic Algorithms: Definition, Applications		
	1.5	Introduction to Deep Learning: Definition and Applications		
2		**Neural Networks**		
	2.1	Fundamental Concepts and Models of Artificial Neural Systems: Biological Neurons and Their Artificial Models, Models of Artificial Neural Networks, Neural Processing, Learning and Adaptation, Neural Network, Learning Rules and Comparison.	**1,4, 5,6, 7,8**	**13**
	2.2	Linearly and Non-Linearly Separable Pattern Classification.		
	2.3	Perceptron Convergence Theorem		
	2.4	Multi-layer Feed forward Network: Delta Learning Rule for Multi-perceptron Layer**,** Generalized Delta Learning Rule, Feed forward Recall and Error Back-propagation Training, Learning Factors		
	2.5	Unsupervised Learning: Self Organizing maps, Adaptive Resonance Theory		

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3		**Fuzzy Set theory**		
	3.1	Properties of Fuzzy Sets, Operations on Fuzzy Sets	2,3, 4,5	10
	3.2	Membership Functions, Fuzzy Extension Principle		
	3.3	Fuzzy Relations, Projection and Cylindrical Extension of Fuzzy Relations, Fuzzy Max-Min and Max-Product Composition.		
	3.4	Defuzzification Methods, Fuzzy Composition Rules, Architecture of Mamdani Type Fuzzy Control Systems.		
	3.5	Fuzzy Knowledge Based Systems with Applications		
4		**Genetic Algorithm**		
	4.1	Biological Background: The Cell, Chromosomes, Genetics, Reproduction, Selection, Traditional Optimization and Search Techniques	4,5,9	6
	4.2	Genetic Algorithm and Search space: Simple GA, General GA, Operators in GA, Stopping Condition for GA		
	4.3	Constraints in GA, Problem solving using GA		
5		**Deep learning**		
	5.1	Supervised: RNN, Deep Belief Net, CNN	10	8
	5.2	Unsupervised: Autoencoders, Deep Generative models, Deep Reinforcement Learning		
			Total	**42**

Recommended Books:

1) Jacek M. Zurada, *"Introduction to Artificial Neural Systems,"* Jaico Publishing House, 1992.
2) Timothy J. Ross, *"Fuzzy Logic with Engineering Applications"*, 3rd edition, Wiley India, 1995.
3) H.J. Zimmermann,*"Fuzzy Set Theory and its Applications"*, 2nd edition, Allied Publishers Ltd., 1996.
4) S. N. Sivanandam and S. N. Deepa, *"Principles of Soft Computing",* 2nd edition, Wiley, India, 2011.
5) Jang J.S.R, Sun C. T. and MizutaniE*.,"Neuro-Fuzzy and Soft Computing– A Computational Approach to Learning and Machine Intelligence"*, 1st edition, PHI, 1997.
6) LaureneFausett, *"Fundamentals of NeuralNetworks – Architectures, Algorithms, And Applications"*, 1st edition, Pearson Education, 2004.
7) Hagan T.Martin, H.B. Demuth, and Mark Beale, *"Neural Network Design"*, 2nd edition, Thomson Learning, 2014.
8) Satish Kumar, *"Neural Networks – A classroom Approach"*, 2nd edition, Tata McGraw Hill, 2009.
9) Melanie Mitchell, *"An Introduction to Genetic Algorithms"*, The MIT Press, 1996.
10) I. Goodfellow, Y. Bengio, A. Courville, F. Bach, *"Deep Learning (Adaptive Computation and Machine Learning)",* 1st Edition, O' Reilly, 2016.

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	**T**	**P**	**L**	**T**	**P**	**Total**
ITE72B	**Cloud Computing**	3	--	--	3	--	--	3
		Examination Scheme						
		ISE		**MSE**		**ESE**	**Total**	
		20		20		60	100	

Pre-requisite Course Codes	IT44 : Operating Systems
	IT61 : Distributed Systems
After successful completion of the course, student will be able to	

	ITE72B.1	Illustrate the fundamentals of Cloud Computing and its challenges.
Course Outcomes	ITE72B.2	Analyze different virtualization techniques and their role in enabling the cloud computing system model.
	ITE72B.3	Classify various architecture and infrastructure of cloud computing.
	ITE72B.4	Analyze some important cloud computing driven systems and cloud applications.
	ITE72B.5	Categorize various security related issues in cloud computing.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction & Principle of Cloud Computing:**		
	1.1	Cloud computing at glance- The Vision of Cloud Computing, Defining a Cloud, Cloud Computing Reference Model, Characteristics, benefits and challenges.	**1**	**5**
	1.2	Historical development - Distributed Systems, Virtualization, Web 2.0, Service-Oriented Computing, Utility-Oriented Computing		
	1.3	Building cloud computing environments - Application Development, Infrastructure and System Development		
	1.4	Computing platform and technology - Amazon Web Services (AWS), Google AppEngine, Microsoft Azure, Hadoop, Force.com and Salesforce.com, Manjrasoft Aneka		
2		**Virtualization**		
	2.1	Introduction to virtualization and characteristics of virtualization environments	**1**	**6**
	2.2	Taxonomy of virtualization techniques - Execution Virtualization, Other Types of Virtualization		
	2.3	Virtualization and cloud computing		
	2.4	Pros and cons of virtualization		
	2.5	Technology Examples		

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3		**Cloud Computing Architecture**		
	3.1	Introduction		
	3.2	Cloud Reference Model - Architecture, Infrastructure / Hardware as a Service, Platform as a Service, Software as a Service		
	3.3	Types of Clouds - Public Clouds, Private Clouds, Hybrid Clouds, Community Clouds	**1**	**6**
	3.4	Economics of the Cloud		
	3.5	Open Challenges - Cloud Definition, Cloud Interoperability and Standards, Scalability and Fault Tolerance, Security, Trust, and Privacy, Organizational Aspects		
4		**Cloud Infrastructure Mechanisms**		
	4.1	Cloud Infrastructure Mechanisms - Logical Network Perimeter, Virtual Server, Cloud Storage Device, Cloud Usage Monitor, Resource Replication Ready-Made Environment.		
	4.2	Specialized Cloud Mechanisms - Automated Scaling Listener, Load Balancer, SLA Monitor, Pay-Per-Use Monitor, Audit Monitor, Failover System, Hypervisor, Resource Cluster, Multi-Device Broker, State Management Database.	**2**	**7**
	4.3	Fundamental Cloud Architectures - Workload Distribution Architecture, Resource Pooling Architecture, Dynamic Scalability Architecture, Elastic Resource Capacity Architecture, Service Load Balancing Architecture, Cloud Bursting Architecture, Elastic Disk Provisioning Architecture, Redundant Storage Architecture, Case Study Example		
5		**Cloud platform in industry and applications**		
	5.1	Amazon web services - Compute Services, Storage Services, Communication Services.	**1**	
	5.2	Google App Engine - Architecture and Core Concepts, Application Life-Cycle, Cost Model.	**1**	
	5.3	Microsoft Azure - Azure Core Concepts, SQL Azure Contents.	**1**	**11**
	5.4	Open source cloud platforms - Eucalyptus, OpenStack.	**4,5,6**	
	5.5	Cloud Applications - Scientific Applications, Business and Consumer Applications	**1**	
	5.6	Mobile Cloud computing: Motivation, Architecture, Issues.	**7**	
6		**Security in Cloud**		
	6.1	Basic Terms and Concepts	**2**	
	6.2	Threat Agents - Anonymous Attacker, Malicious Service Agent, Trusted Attacker, Malicious Insider	**2**	
	6.3	Cloud Security Threats - Traffic Eavesdropping, Malicious Intermediary, Denial of Service, Insufficient Authorization, Virtualization Attack, Overlapping Trust Boundaries, Common Attacks, Cloud-Specific Attacks	**2,3**	**7**
	6.4	Additional Considerations - Flawed Implementations, Risk Management	**2**	
Total				**42**

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Recommended Books:

1) RajkumarBuyya, Christian Vecchiola,SThamaraiSelvi, "*Mastering Cloud Computing Foundations and Applications Programming*", Elsevier Inc, 2013.
2) Thomas Erl, ZaighamMahood, Ricardo Puttini, "*Cloud Computing, Concept, Technology and Architecture*", Prentice Hall, 2013.
3) Zaigham Mahmood, "*Cloud Computing - Challenges, Limitations and R&D Solutions*", Springer International Publishing, 2014.
4) Nurmi, Daniel and Wolski, Rich and Grzegorczyk, Chris and Obertelli, Graziano and Soman, Sunil and Youseff, Lamia and Zagorodnov, Dmitrii, "*Eucalyptus: An Open Source Cloud Computing Infrastructure*", Journal of Physics: Conference Series, Vol. 180, No. 1, 2009.
5) D. Nurmi, R. Wolski, C. Grzegorczyk, G. Obertelli, S. Soman, L. Youseff, and Zagorodnov, "*The Eucalyptus Open-Source Cloud-Computing System*", Proceedings of 2009 ACM/IEEE International Conference on Grid Computing (CCGrid 2009).
6) OpenStack Team, "*Red Hat OpenStack Platform 9 Architecture Guide Introduction to the product, components, and architectural examples*", Red Hat, Inc, 2017.
7) Debashis De, "Mobile Cloud Computing Architectures, Algorithms and Applications", CRC Press, 2016.

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	**T**	**P**	**L**	**T**	**P**	**Total**
		3	-	-	3	-	-	3
ITE72C	**IT Infrastructure Management**	**Examination Scheme**						
		ISE		**MSE**	**ESE**		**Total**	
		20		**20**	**60**		**100**	

Pre-requisite Course Codes	ITL36 : Open Source Operating System Lab IT52: Computer Networks IT61 : Distributed Systems IT63: Information and Network security
After successful completion of the course, student will be able to	
Course Outcomes	ITE72C.1	Identify the requirements to set up an IT infrastructure.
	ITE72C.2	Identify the service delivery Processes & Service support process
	ITE72C.3	Illustrate the different component of storage network architecture
	ITE72C.4	Identify the use of Information Technology Infrastructure Library
	ITE72C.5	Design the data center infrastructure.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**IT infrastructure**		
	1.1	Introduction, challenges, design issues in IT organization and IT infrastructure.		
	1.2	Determining customer's requirements	**1-4**	**7**
	1.3	IT systems, management process, IT service management process, Information system design process,		
	1.4	Patterns for IT systems management, IT infrastructure library		
2		**IT Infrastructure Management**		
	2.1	Factors to consider in designing IT organizations and IT infrastructure,		
	2.2	Determining customer's Requirements, Identifying System Components to manage, Exist Processes, Data, applications, Tools and their integration, Patterns for IT systems management	**1-4**	**6**
	2.3	Introduction to the design process for information systems, Models, Information Technology Infrastructure Library (ITIL).		
3		**Current computing environment**		
	3.1	Complexity of current computing, multiple technologies, multiple vendors, multiple users.	**1-4**	**4**
	3.2	e- Waste disposal, Total cost of ownership		

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4		**Service Delivery Processes & Service support process:**		
	4.1	Service Delivery Processes : Service delivery process Service level management, financial management, IT service continuity management, capacity management, availability management	**1-4**	**6**
	4.2	Service support process: Configuration management, incident management, problem management, change management, release management		
5		**Storage Networking**		
	5.1	Types of Storage management, Benefits of storage management, backups, Archive, Recovery, Disaster recovery. Storage area networks - Fiber channel: Protocol, topologies, addressing, services. - The iSCSI protocol - SAN benefits - Storage virtualization	**1-4**	**6**
6		**Data Center Infrastructure**		
	6.1	Data Center Infrastructure Architecture Overview - Data Center –site location and site configuration, Various Elements in a Data centre-their functions, Hardware and Software Recommendations, Software Recommendations, Data Center Multi-Layer Design,	**1-4**	**8**
	6.2	Network Management Data Center Infrastructure Design - Data Center Design Models Routing Between the Data Center and the Core, Switching Architecture for the Server Farm Data Center Infrastructure		
7		**Data Center Security**		
	7.1	Security aspects in a Data Centre, Packet Filtering: Aggregation Layer,	**1-4**	**3**
	7.2	Packet Filtering: Access Layer, Security for Multi-Tier Server Farms, Intrusion Detection Sensors		
8		**Virtual Data Centre**		
	8.1	What is a Virtual data Centre, Virtual Data Centre management, Remote Management	**1-4**	**2**
			Total	**42**

Recommended Books:

1) Anita Sengar, *"I.T. Infrastructure Management",* 2nd Edition, S. K. Kataria & Sons, 2009.
2) Mauricio Arregoces, Maurizio Portolani, *" Data Center Fundamentals",* 6nd Edition by Cisco Press 2009
3) Phalguni Gupta,*" IT Infrastructure & Its Management"*,1st Edition ,Tata McGraw-Hill Education, October 2009
4) Munesh Chandra Trivedi, *"Information Technology Infrastructure & Its Management"*, 1st Edition , Khanna Publishing; December 2014.

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
ITL71	Digital Image Processing Lab	--	--	2	--	--	1	1
		Examination Scheme						
		ISE		MSE		ESE		Total
		40		--		--		40

Pre-requisite Course Codes	Programming in C/Java/Python	
After successful completion of the course, student will be able to		
Course Outcomes	ITL71.1	Identify the techniques to enhance the subjective quality of the image of different resolutions.
	ITL71.2	Analyze an image using Image Transform.
	ITL71.3	Extract the important features from image data to solve real life problem.
	ITL71.4	Apply the compression technique on digital images and compute its efficiency.

Exp. No.	Suggested List of Experiments	Ref.	Marks
1	Write a program to perform following operation on Image. a. Digital Negative. b. Grey Level Slicing. c. Thresholding.	1,2	5
2	Write a program to enhance image using histogram equalization.	1,2	5
3	Write a program to compute Discrete Fourier Transform.	1,2	5
4	Write a program to enhance image using Smoothing and Sharpening Filters.	1,2	5
5	Write a program to implement Image Segmentation using Gradient/Prewitt/Robert/Sobel Operators.	1,2	5
6	Write a program to perform Morphological image processing using Erosion, Dilation, Opening and Closing.	1,2	5
7	Write a program to implement Compression using RLE Compression Algorithm on an Image.	1,2	5
8	Mini Project on an application of Image Processing	1,2	5
		Total	**40**

Note: Case study taken for project can be used for the experiments.

Recommended Books:
1) Gonzalez and Woods, "*Digital Image Processing*", 4th Edition, Pearson Education, 2018.
2) Jain A. K., "*Fundamentals of Digital Image Processing*", Pearson Education, 2015.

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
ITEL71A	Data Analytics Lab	--	--	2	--	--	1	1
		Examination Scheme						
		ISE		MSE		ESE		Total
		40		--		--		40

Pre-requisite Course Codes	ITL62 : Data Warehousing and Mining Lab	
	ITL64 : Machine Learning Lab	
Course Outcomes	ITEL71A.1	Apply Map Reduce on string and integers.
	ITEL71A.2	Make use of modern tools to analyze the best practices in data science.
	ITEL71A.3	Apply map-reduce on Big data algorithms like Frequent Item set algorithm, Clustering, Data streaming algorithm.
	ITEL71A.4	Make use of software tools like Pig, Hive, Hbase etc. for data analytics.

Exp. No.	Experiment Details	Ref.	Marks
1	Installation of Hadoop and execution of HDFS commands	1	5
2	Implement algorithms in Map-Reduce on Strings and integers	3	5
3	Implement algorithms in Map-reduce on Relational Algebra	3	5
4	Implement link analysis to identify page rank of web pages.	4	5
5	Use of open source tools like Pandas for finding Summary statistics (mean, median, mode, variance, standard deviation)	2	5
6	Study and use tools (plots, graphs and summary statistics) of Exploratory Data Analysis Case Study: RealDirect (online real estate firm)	2	5
7	Data Visualization: Create your own visualization of a complex dataset	2	5
8	Analyze statistical data using R programming	5	5
		Total	40

Recommended Books:
1) Tom White, "*Hadoop: The Definitive Guide*", 3rd Edition, O' Reilley, 2012.
2) Anand Rajaraman and Jeff Ullman, "*Mining of Massive Datasets*", 2nd edition, Cambridge University Press2.
3) Alex Holmes, "*Hadoop in Practice*", 2nd edition, Dreamtech Press.
4) Eric Sammer, *"Hadoop Operations"*, O'Reilley, 2012.
5) Roger D. Peng, "*R Programming for Data Science*", 1st Edition 2016.

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
ITEL71B	**Ad-hoc and Wireless Sensor Network Lab**	--	--	2	--	--	1	1
		Examination Scheme						
		ISE		**MSE**		**ESE**		**Total**
		40		--		--		40

Pre-requisite Course Codes	IT52: Computer Networks
	ITL52: Computer Networks Lab
After successful completion of the course, student will be able to	

	ITEL71B.1	Estimate the performance of the Network.
Course Outcomes	ITEL71B.2	Create a Wireless Ad-hoc Network.
	ITEL71B.3	Analyze the Protocols for Personal Area Networks
	ITEL71B.4	Build a Wireless Sensor Network.

Exp. No.	Suggested List of Experiments	Ref.	Marks
1	Measure Network Performance: Throughput, Delay, Packet drop.	3	5
2	Simulate Wireless network: Creating a simple wireless scenario, Using node-movement/traffic-pattern files and other features in wireless simulations.	3	5
3	Simulate Wi-Fi Network : Use of RTS/CTS to Exchange Data Issues in Wi-Fi Networks The Hidden Terminal Problem Solution of Hidden Terminal Problem.	1	5
4	Simulate Wireless Local Area Network.	1	5
5	Simulate Mobile Ad-hoc Network: Routing protocols for MANET Destination-Sequenced Distance-Vector algorithm, Dynamic source routing.	1	5
6	Setting up a Bluetooth Network: simulates the formation of piconets and scatternets.	1	5
7	Setting up a ZigBee Network: Configure a star topology which consist of seven nodes in zigbee network and find energy consumption with beacon order for different super frame order.	1	5
8	Simulate a Wireless Sensor Network.	2	5
		Total	**40**

Recommended Books:

1) C.K. Toh, "*Ad hoc Mobile Wireless Networks – Protocols and Systems*", 1st Edition, Pearson Education, 2007.
2) Kazem Sohraby, Daniel Minoli, TaiebZnati, "*Wireless Sensor Networks*", 1st Edition, Wiley Interscience, 2007.
3) https://www.isi.edu/nsnam/ns/

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
ITEL71C	AI and Expert System Lab	--	--	2	--	--	2	1
		Examination Scheme						
		ISE		MSE		ESE		Total
		40		--		--		40

Pre-requisite Course Codes	ITC31:Advanced Data Structures ITC41: Design and Analysis of Algorithms
After successful completion of the course, student will be able to	
Course Outcomes	ITEL71C.1	Utilize knowledge based reasoning to solve certain problems
	ITEL71C.2	Apply different uninformed and informed search techniques to solve various problems
	ITEL71C.3	Apply adversarial search techniques to solve problems
	ITEL71C.4	Implement programs in declarative programming style using Prolog
	ITEL71C.5	Design intelligent agents for solving a particular problem

Exp. No.	Suggested List of Experiments	Ref.	Marks
1	Implement uninformed search algorithm	1,2	5
2	Implement knowledge based reasoning	1,4	5
3	Implement informed search methods	1,2	5
4	Program on Local Search Algorithm	1,2	5
5	Program on planning algorithm	1,3	5
6	Program on Adversarial Search	1,2	5
7	lisp and prolog programming problems	1, 4	5
8	One case study on Expert system based papers published in IEEE/ACM/Springer or any prominent journal	5, Journal Paper	5
		Total	40

Recommended Books:

1) Stauart Russell and Peter Norvig, "*Artificial Intellingence*: A Modern approach", 3rd Edition, Prentice Hall, New Jerset,1995.
2) Elaine Rich and Kelvin Knight, "*Artificial Intelligence*" , 3rd Edition, Tata McGraw Hill, New Delhi,1991.
3) Nilson N.J., "*Principles of Artificial Intelligence*", Springer Verlag, Berlin,1980.
4) Patterson "*Introduction to Artificial Intelligence and Expert systems*", 1st Edition Prentice Hall of India, New Delhi,1990.
5) Robert J shalkoff, "*Artificial Intelligence: An Engineering Approach*", 1st Edition McGraw Hill international Edition,1990.

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
ITEL72A	Soft Computing Lab	-	-	2	-	-	2	1
		Examination Scheme						
		ISE		MSE		ESE		Total
		40		-		-		40

Pre-requisite Course Codes	ITL64: Machine Learning Laboratory	
After successful completion of the course, student will be able to		
Course Outcomes	ITEL72A.1	Apply supervised and unsupervised learning algorithms on various input patterns
	ITEL72A.2	Apply genetic algorithm for solving optimization problems
	ITEL72A.3	Measure the performance of deep learning algorithms using open source tools
	ITEL72A.4	Design fuzzy logic control systems
	ITEL72A.5	Choose a suitable soft computing technique for a given scenario

Exp. No.	Suggested List of Experiments	Ref.	Marks
1	To implement various learning rules.	1,5	05
2	To apply back-propagation supervised learning algorithm for an application.	1,5	05
3	To apply SOM unsupervised learning algorithm for pattern classification problem.	1,5	05
4	To implement fuzzy membership functions in Scilab.	3,4	05
5	To design and implement Fuzzy Controller for a given problem.	3,4	05
6	To apply genetic algorithm for a given problem.	5	05
7	To compare the performance of various deep learning algorithm for solving a given problem using TensorFlow, Keras etc.	6,7	05
8	Choose appropriate soft computing technique for a given scenario.	1,2,3,4,5,6,7	05
		Total	40

Recommended Books:

1) Jacek M. Zurada, "*Introduction to Artificial Neural Systems,*" Jaico Publishing House, 1992.
2) Kishan Mehrotra, Chilukuri. K.Mohan and Sanjay Ranka, *"Elements of Artificial Neural Networks"*, 2nd Edition, Penram Int. Publishing India, 2009.
3) H.J. Zimmermann,*"Fuzzy Set Theory and its Applications"*, 2nd Edition, Allied Publishers Ltd., 1996.
4) Driakov D., Hellendoorn H., and Reinfrank M., "*An Introduction to Fuzzy Control*", 2nd Edition, Narosa Publishing House, 1996.

5) S. N. Sivanandam and S. N. Deepa, *"Principles of Soft Computing",* 2nd Edition, Wiley, India, 2011.

6) T. Hope, Y Resheff, I. Lieder , *"Learning TensorFlow: A Guide to Building Deep Learning Systems",* 1st Edition, O' Reilly, 2017.

7) G. Zaccone, R. Karim, A. Menshawy, *"Deep Learning with TensorFlow"*, 1st Edition, PACKT Publications, 2017.

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
ITEL72B	Cloud Computing Lab	--	--	2	--	--	2	1
		Examination Scheme						
		ISE		MSE		ESE		Total
		40		--		--		40

Pre-requisite Course Codes	IT44:Operating System IT52:Computer Networks ITL36:Open Source Software Lab
After successful completion of the course, student will be able to	
Course Outcomes	ITEL72B.1	Perform virtualization configuration and administration
	ITEL72B.2	Handle open source cloud implementation and administration.
	ITEL72B.3	Create and run virtual machines.
	ITEL72B.4	Install and appreciate security features for cloud.
	ITEL72B.5	Install and use cloud simulator.

Exp. No.	Suggested List of Experiments	Ref.	Marks
1	Implement Desktop and Server Virtualization.	1	5
2	Implement OS Level Virtualization.	1	5
3	Implementation of Platform As A Service.	2	5
4	Implementation of Storage as a Service.	2	5
5	Implementation of Infrastructure As A Service - Deploy OpenStack Single Node with - OpenStack Compute (Nova) - OpenStack Networking (Neutron) - OpenStack Identity (Keystone) - OpenStack Image (Glance) - OpenStack Block Storage (Cinder) - OpenStack Dashboard (Horizon)	2,4	5
6	Implementation of Infrastructure As A Service - Getting Familiar with End-User/ Cloud Operator Tasks: - Create an instance using API and Dashboard - Understand conf and log files - Understand basics of APIs and framework architecture - Understand shared components - Work off a single node openstack implementation	2,4	5
7	Implementation of Single-Sign-On and Securing Servers in Cloud	2,3	5
8	Implementation of cloud simulator.	2	5
		Total	40

Recommended Books:

1) Bernard Golden, *"Virtualization for Dummies"*, Wiley Publication.
2) Dr. Kumar Saurabh, *"Cloud computing"*, Wiley Publication.
3) Ronald L., *"Cloud security"*, Wiley Publication.
4) https://docs.openstack.org/install-guide/

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
ITEL72C	IT Infrastructure Management Lab	--	--	2	--	--	2	1
		Examination Scheme						
		ISE		MSE		ESE		Total
		40		--		-		40

Pre-requisite Course Codes	ITL36: Open Source Operating System Lab IT52: Computer Networks IT61: Distributed Systems IT63: Information and Network security
After successful completion of the course, student will be able to	
Course Outcomes	ITEL72C.1	Identify the requirements for IT infrastructure
	ITEL72C.2	Identify ITIL components for IT infrastructure .
	ITEL72C.3	Design network management.
	ITEL72C.4	Design data center virtualization
	ITEL72C.5	Apply security for IT infrastructure

Exp. No.	Suggested List of Experiments	Ref.	Marks
1	Requirement analysis and network panning for IT infrastructure	1-4	5
2	Identify the ITIL components of IT infrastructure	1-4	5
3	Simulation of SAN	1-4	5
4	Configuring Network Management, VLAN Configuration, Spanning Tree Configuration.	1-4	5
5	Switch-To-Switch Connections Configuration, Server Port Configuration	1-4	5
6	Case study on data center	1-4	5
7	Design Security for Multi-Tier Server Farms	1-4	5
8	Data center Virtualization	1-4	5
		Total	40

Recommended Books:

1) Anita Sengar, *"I.T. Infrastructure Management"*, 2nd Edition, S. K. Kataria & Sons, 2009.
2) Mauricio Arregoces, Maurizio Portolani, *" Data Center Fundamentals"*, 6nd Edition by Cisco Press 2009
3) Phalguni Gupta,*" IT Infrastructure & Its Management"*,1st Edition ,Tata McGraw-Hill Education, October 2009
4) Munesh Chandra Trivedi, *"Information Technology Infrastructure & Its Management"*, 1st Edition, Khanna Publishing, December 2014.

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
OE1	Consumer Electronics	1	--	2	1	--	1	2
		Examination Scheme						
		ISE		MSE		ESE		Total
		40		10		20		70

Pre-requisite Course Codes	ES1: Basic Electrical and Electronics Engineering	
After successful completion of the course, student will be able to		
Course Outcomes	OE1.1	List and classify devices used in consumer products based on their specifications, identify sub-systems of consumer electronic products,also choose and use proper interface standard for a given consumer electronic product
	OE1.2	Illustrate working principle of consumer electronic products and carry out basic tests to identify their correct operation.
	OE1.3	Experiment with Haptics, Multitouch devices, Device interconnects and peripherals and also suggest modification in consumer electronic product using modern tools to enhance user experience
	OE1.4	Assemble subsystem of Television set and analyze technology used in audio systems.
	OE1.5	Demonstrate working principal of Healthcare and home electronics consumer products.
	OE1.6	Demonstrate working principal consumer electronic products used in Occupational safety.

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1	**Introduction to consumer Electronic.**	4	02
	1.1	Haptics and Multi-touch Devices: Introduction to Touch panel, Capacitive Touch screen, Light pen.		
	1.2	Displays for Consumer Electronics: OLED Display, Alphanumeric Display, LED Display, LCD Display.		
	1.3	Miscellaneous Devices: Mice, Trackballs, Virtual Reality.		
	1.4	Gaming Devices; Joystick.		
2	2	**Device Interconnects and Peripherals.**	3	02
	2.1	Introduction to Serial Interfaces, RS-232, I2C, SPI, USB.		
	2.2	Introduction to ZIG-BEE Standards, WI-FI, Bluetooth, Thunderbolt, JTAG and various Interconnection standards.		
3	3	**Interactive and Immersive TV.**	1	02
	3.1	Introduction to Television, PAL TV System, NTSC TV System, SECAM TV System.		
	3.2	Advanced Television System: 3D TV, High Definition TV, Digital Satellite TV, 4K TV, Plasma Displays.		

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4	4	**Audio System Technologies and Home electronics.**	1	02
	4.1	Introduction to Audio system and major components of Audio System, Microphone, Loudspeaker, HI-FI, Stereophony, Public Address System, Noise Cancelling Headphones.		
	4.2	Introduction to Home Electronics, Microwave Oven, Refrigerator, Air Conditioning System, Washing Machine.		
5	5	**Healthcare Electronics.**	6	02
	5.1	Wearable Devices: Activity Trackers Smart Watch, Smart Glass.		
	5.2	Fitness Devices: Blood Pressure Monitor, Digital Weighing Scale, Digital Glucometer.		
	5.3	Biomedical Devices: ECG Sensor, EKG Sensor, EMG Sensor, Respirators.		
6	6	**Consumer Electronics used in Occupational Safety.**	2	02
	6.1	Printers, Scanners, Projection System.		
	6.2	Bio-metric Devices: Finger Print Scanner, IRIS Scanner.		
	6.3	Security Devices: CCTV, Electronics Lock, Video Intercom System, Door bell.		
7	7	**New and Emerging Technologies.**	5	02
	7.1	E-platforms for Selecting Consumer Electronics.		
	7.2	E-payments.		
			Total	**14**

Teaching Learning Methodology in Laboratory: Role Play Model

a) **Instructor:**
   Responsibilities: Explanation of theoretical background
   To provide required sample formats
   To guide students in identification of appropriate online material.
   Supervision and assessment of the overall activity

b) **First Group of students : Customer**
   Responsibilities: To finalize specifications of instrument to be purchased
   Prepare request for quotations
   Prepare the comparative statement
   Preparation for purchase order

c) **Second Group of students: Manufacturer/Vendor**
   Responsibilities: To maintain the specifications of the manufactured instruments
   To submit quotations including all applicable taxes
   To prepare Invoice as per purchase order

d) **Third Group of Students: Sales/Service Engineer**
   Responsibilities: To demonstrate capabilities of various instruments and convince
   customer to purchase a particular instrument
   To prepare Delivery Challan
   Install the instruments and prepare Installation Report,
   Demonstrate all the functions and uses of the instrument

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Exp. No.	Suggested List of Experiments	Ref.	Marks
1	Experiment on Haptics and Multi-touch devices.	4	5
2	Experiment on Device interconnects and Peripherals (USB and Bluetooth).	3	5
3	Experiment on assembly of parts used in Television set.	1	5
4	Experiment on Audio system technology.	1	5
5	Experiment on Home electronics Consumer products.	2	5
6	Experiment on Wearable and fitness devices.	6	5
7	Experiment on Biomedical data acquisition devices.	5	5
8	Experiment on occupational safety in electronic devices.	2	5
		Assessment Marks	**40**

ISE Evaluation: Continuous evaluation of experiments for 40 Marks

MSE Evaluation: Subjective evaluation for 10 Marks based on theory for one hour duration

ESE Evaluation: Subjective evaluation for 20 Marks based on theory for one hour duration

Recommended Books:
1) S. P. Bali, "*Consumer Electronics*", Pearson Education, 1st Edition, 2005.
2) Peter H. Gregory, "*Biometrics for Dummies*", Wiley Publishing Inc., 2008.
3) N. Mathivanan, "*PC Based Instrumentation: Concepts and Practices*", Prentice Hall Learning India Pvt. Ltd., 1st Edition, 2007.
4) Deborah Morley, "*Understanding Computers: Today and Tomorrow*", Course Technology, 16th Edition, 2016.
5) N. Jilovec, "*E-Business: Thriving in Electronics Marketplace*", 29th Street Press, 1st Edition, 2000.
6) Sanjay Mishra, "*Wearable Android: Android Wear and Google FIT App Development*", Wiley Blackwell publication, 1st Edition, 2015.

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
OE2	Robotic Vision	1	--	2	1	--	1	2
		Examination Scheme						
		ISE		MSE		ESE		Total
		40		10		20		70

Pre-requisite Course Codes	EL42: Principle of Control Systems	
At the end of the course students will be able to		
Course Outcomes	OE2.1	Discuss the fundamentals of Robotics
	OE2.2	Apply direct and inverse kinematics algorithms
	OE2.3	Justify the need of vision algorithms

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1	**Fundamentals of Robotics**		4
	1.1	Robot Classification, Robot Components, Degrees of freedom, Joints, Coordinates, Coordinate frames		
	1.2	Transformation matrix, inverse Transformation matrix,		
	1.3	Screw Transformation, Link co-ordinates		
2	2	Forward and Inverse kinematic equation, D-H Representation		4
	2.1	The Arm Matrix		
3	3	**Introduction to Robot Vision**		3
	3.1	Image Representation, Edge Detection		
	3.2	3D image to 2D image Transformation		
	3.3	Stereo Vision		
4	4	Edge Detection , Template Matching,		3
	4.1	Object detection and recognition		
	4.2	Object Classification		
		Total		14

Expt. No.	Suggested List of Experiments	Ref.	Marks
1	Identify the types of robot based on configuration and application.	1,2	5
2	Using the information based on length of links and no. of joints, specified angles verify the DH algorithm for forward kinematics and also to determine the maximum and minimum position of links.	1,2	5
3	Design a robots drive system and its end effectors for a given application.	1,2,3	5

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4	Verify the transformation (Position and orientation) with respect to gripper and the coordinate system using any simulation software.	1,2	5
5	Estimation of accuracy, repeatability and resolution of a given robotic manipulator.	1,2	5
6	Robot programming exercises (Point-to-point and continuous path programming)	1,2,3	5
7	Edge detection		4
8	Object Detection		4
9	Object recognition using Template Matching		4
10	Vision based Application development		4
	Eight Experiments Total Marks		**40**

ISE Evaluation: Continuous evaluation of experiments for 40 Marks

MSE Evaluation: Subjective evaluation for 10 Marks based on theory for one hour duration

ESE Evaluation: Subjective evaluation for 20 Marks based on theory for one hour duration

Recommended Books:

1) Robert Shilling, "*Fundamentals of Robotics - Analysis and control, Prentice Hall of India*", 4th Edition [ISBN-81-203-1047-0].
2) Howie Choset, Kevin M. Lynch, Seth Hutchinson, George Kantor, Wolfram Burgard, Lydia E.
3) Mittal R.K. & J. Nagrath, "*Robotics and Control*", TataMcGraw Hill, 2003 [ISBN 0-07-048293-4].
4) Milan Sonka, Vaclav Hlavac and Roger Boyle, "*Image Processing, Analysis and Machine Vision*", Second Edition, Thomson Brooks/Cole 2004 [ISBN: 981-240-061-3].

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
OE3	Cyber security and Digital Forensics	1	-	2	1	-	1	2
		Examination Scheme						
		ISE		MSE		ESE		Total
		40		10		20		70

Pre-requisite Course Codes		Computer Basics, Networking basics
Course Outcomes	OE3.1	Identify and classify various cybercrimes with respect to organizational weaknesses in order to mitigate the security risk and estimate the impact on society and world.
	OE3.2	Analyze the results of vulnerability scans of vulnerability assessment and generate report with penetration testing.
	OE3.3	Apply Information Security Standards compliance during software design and development.
	OE3.4	Interpret and apply Indian IT laws in various legal issues.
	OE3.5	Describe the concept of Digital forensics and use various tools and techniques used for digital forensics investigations.
	OE3.6	Integrate advanced security solutions and manage, provide policies, standards, procedures, guidelines, policy framework, assess and mitigate risk.

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1.1	**Introduction to Cyber Security**	1,2	1
	1.2	Cybercrime definition and origins of the world, Cybercrime and information security, Classifications of cybercrime,	1,2	1
	1.3	Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.	1,2	1
2	2.1	**Cyber offenses & Cybercrimes:** How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector,Credit Card Frauds in Mobile and Wireless Computing Era, Security,Challenges Posed by Mobile Devices	1,2	1
	2.2	Tools and Methods Used in Cybercrime: Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks,Identity Theft (ID Theft)	1.2	1

3	3.1	**Security Risk Assessment and Risk Analysis:** Risk Terminology, Laws, Mandates, and Regulations,Risk Assessment Best Practices,The Goals and Objectives of a Risk Assessment, Best Practices for Quantitative and Qualitative Risk Assessment.	7,8, 10	1
	3.2	**Vulnerability Assessment and Penetration Testing (VAPT):** VAPT An Overview,Goals and Objectives of a Risk and Vulnerability Assessment,	7,8, 10	1
	3.3	Vulnerability Assessment Phases - Discovery, Exploitation/ Analysis, Reporting Penetration Testing Phases - Discover/Map, Penetrate Perimeter, Attack Resources, Network and Web VAPT Process	7.8, 10	1
4	4.1	**Cyber Security Laws and Legal Perspectives**	1,2, 4,6	1
	4.2	Cyber Crime and Criminal Justice: Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	1,2, 4,6	1
	4.3	Information Security Standard compliances: SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI-DSS	1,2, 4,6	1
5	5.1	**Digital Forensics:** Need for forensics, Cyber forensics and Digital Evidence	1,2	1
	5.2	Digital Forensics Life cycle, Computer forensics investigation, setting-up forensics laboratory, Special Tools and Techniques, Forensics Auditing and Compliance Requirements, Anti forensics	1,2	1
	5.3	Forensics of Hand-held devices,Tool-kits for Hand-held device forensics, Techno-Legal Challenges with Evidence from Hand-held Devices	1,2	1
			Total	**14**

Teaching Learning Methodology in Laboratory: Role Play Model

a) Instructor:

Responsibilities: Explanation of theoretical background

To provide required course material

To guide students in identification of appropriate online material

Supervision and assessment of the overall activity

b) First Group of students: Offensive and Defensive

Responsibilities: To define cybercrime and classification of cybercrimes

List the tools and methods used in cybercrimes

Prepare the list best cyber security practices

c) Second Group of students: Vulnerability Assessor and Penetration Tester (VAPT)

Responsibilities: To assess the vulnerabilities of systems (OS, Network infrastructure etc)

To carry out penetration testing and reporting

To abide by regulatory compliance and security standards

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d) Third Group of Students: Forensic Investigator (FI)
Responsibilities: To setup laboratory for forensics

To use tools and techniques of digital forensics

To preserve the evidence

Demonstrate the forensic investigation process

Exp. No	Suggested List of Experiments	Ref.	Marks
1	Network commands and utilities	13,15	5
2	Install and configure Virtual Environment	14	5
3	Information Gathering, Sniffing and scanning	13,15	5
4	Vulnerability Scanning and Vulnerability Assessment	13,15	5
5	Penetration Testing using Metasploit	16	5
6	Firewalls and Intrusion Detection System (IDS)	13	5
7	Encryption Tools	13	5
8	Forensics Tools and Utilities	13	5
	Assessment Marks		40

ISE Evaluation: Continuous evaluation of experiments for 40 Marks
MSE Evaluation: Subjective evaluation for 10 Marks based on theory for one hour duration
ESE Evaluation: Subjective evaluation for 20 Marks based on theory for one hour duration

Recommended Books:

1) Nina Godbole, Sunit Belapure, "*Cyber Security*", Wiley India, New Delhi.
2) "*The Indian Cyber Law*" by Suresh T. Vishwanathan; Bharat Law House New Delhi.
3) "*The Information technology Act, 2000*"; Bare Act- Professional Book Publishers, New Delhi.
4) "*Cyber Law & Cyber Crimes*" By Advocate Prashant Mali; Snow White Publications, Mumbai.
5) Nina Godbole, "*Information Systems Security*", Wiley India, New Delhi.
6) Kennetch J. Knapp, "*Cyber Security & Global Information Assurance*" Information Science Publishing.
7) Michael Gregg & David Kim, "*Inside Network Security Assessment: Guarding Your IT Infrastructure*", Pearson Publication.
8) M. L. Srinivasan, "*CISSP in 21 Days*" - Second Edition PACT Publication.
9) Charles P. Pfleeger and Shari Lawrence Pfleeger, "*Security in Computing*", Pearson Publication.
10) Douglas J. Landoll, The Security Risk, "*Assessment Handbook-Second Edition*", Auerbach Publications
11) Websites for more information is available on : The Information Technology ACT, 2008-TIFR : https://www.tifrh.res.in
12) https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-33538
13) "*Open Source Security Tools: A Practical Guide to Security Applications*" by Tony Howlett, Pearson Education
14) https://www.virtualbox.org
15) "*Hands-On Information Security Lab Manual*" by Michael Whitman, Cengage publication
16) https://www.offensive-security.com/metasploit-unleashed/

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
OE4	Internet of Things	1	-	2	1	-	1	2
		Examination Scheme						
		ISE		MSE		ESE		Total
		40		10		20		70

Pre-requisite Course Codes		
Course Outcomes	OE4.1	Describe IoT value chain structure (device, data cloud), application areas, IoT sensors and technological challenges faced by IoT devices, with a focus on wireless, energy, power, RF and sensing modules.
	OE4.2	Explain the embedded concepts and embedded system architecture and programming of ARM Cortex Microcontroller for various applications.
	OE4.3	Describe the Architectural Overview of IoT, Reference Architecture and Real World Design Constraints and various IoT Protocols (Datalink, Network, Transport, Session, Service)
	OE4.4	Apply the concepts of big data analytics, Internet of things and implement smart systems.
	OE4.5	Build the Security requirements in IoT, Cryptographic fundamentals, the authentication credentials, various types Trust models and Cloud Security.
	OE4.6	Design a complete secure IoT System for various real time applications.

Module No.	Unit No.	Topics	Ref.	Hrs.
1[CO1]	1.1	**Internet of Things:** Internet of Things Promises–Definition–Scope–Sensors for IoT Applications–Structure of IoT– IoT Map Device.	1,2,3	1
	1.2	**Seven Generations of IoT sensors to Appear**:Industrial sensors – Description & Characteristics–First Generation – Description & Characteristics – Advanced Generation – Description & Characteristics – Integrated IoT Sensors – Description & Characteristics – IoT Generation Roadmap.	1,2,3	1
	1.3	**Technological Analysis:** Wireless Sensor Structure – Energy Storage Module – Power Management Module – RF Module – Sensing Module. IoT Development Examples: ACOEM Eagle – EnOcean Push Button – NEST Sensor – Ninja Blocks - Focus on Wearable Electronics	1,2,3	1
2[CO2]	2.1	**Embedded System Design & Architecture:** Introduction to embedded systems, Application Areas, Categories of embedded systems, Overview of embedded system architecture, Specialties of embedded systems, recent trends in embedded systems, Architecture of embedded systems, Hardware architecture, Software	4,5,6	1

		architecture, Application Software, Communication Software.		
	2.2	**Overview of ARM and Cortex-M3/M4 Programming:** Background of ARM Architecture, Architecture Versions, Processor Naming, Instruction Set Development, Thumb-2 and Instruction Set Architecture. Cortex-M3 Basics.Cortex-M3/M4 Programming: Overview, Typical Development Flow, Using C, CMSIS (Cortex Microcontroller Software Interface Standard), Using Assembly. Exception Programming:	4,5, 6	1
3[CO3]	**3.1**	**IoT Architecture and Protocols:** IoT-An Architectural Overview– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations. M2M and IoT Technology Fundamentals- Devices and gateways, Local and wide area networking, Data management, Business processes in IoT, Everything as a Service(XaaS), M2M and IoT Analytics, Knowledge Management.	7,8, 9,10	1
	3.3	**IoT Data Link Layer & Network layer Protocols:** PHY/MAC Layer(3GPP MTC, IEEE 802.11, IEEE 802.15), WirelessHART,Z-Wave,Bluetooth Low Energy, Zigbee Smart Energy, DASH7 - Network Layer-IPv4, IPv6, 6LoWPAN, 6TiSCH,ND, DHCP, ICMP, RPL, CORPL, CARP.	7,8, 9,10	1
	3.4	**Transport & Session Layer Protocols:**Transport Layer (TCP, MPTCP, UDP, DCCP, SCTP)-(TLS, DTLS) – Session Layer-HTTP, CoAP, XMPP, AMQP, MQTT	7,8, 9,10	1
	3.5	**Service Layer protocols & Security:** Service Layer -oneM2M, ETSI M2M, OMA, BBF – Security in IoT Protocols – MAC 802.15.4 , 6LoWPAN, RPL, Application Layer.	7,8, 9,10	1
4[CO4]	**4.1**	**Big Data Analytics for IoT:** Big Data Platforms for the Internet of Things: network protocol-data dissemination –current state of art- Improving Data and Service Interoperability with Structure, Compliance, Conformance and Context Awareness: interoperability problem in the IoT context- Big Data Management Systems for the Exploitation of Pervasive Environments - Big Data challenges and requirements coming from different Smart City applications.	11, 12	1
	4.2	**Fog Computing:** A Platform for Internet of Things and Analytics: a massively distributed number of sources - Big Data Metadata Management in Smart Grids: semantic inconsistencies – role of metadata	11, 12	1
	4.3	**Sustainability Data and Analytics:** Sustainability Data and Analytics in Cloud-Based M2M Systems - potential stakeholders and their complex relationships to data and analytics applications - Social Networking Analysis - Building a useful understanding of a social network - Leveraging Social Media and IoT to Bootstrap Smart Environments : lightweight Cyber Physical Social Systems -	11, 12	1

		citizen actuation.			
5[CO5]	5.1	**Privacy and Security in IoT**: Security Requirements in IoT Architecture - Security in Enabling Technologies - Security Concerns in IoT Applications. Security Architecture in the Internet of Things - Security Requirements in IoT - Insufficient Authentication/Authorization - Insecure Access Control - Threats to Access Control, Privacy, and Availability - Attacks Specific to IoT. Vulnerabilities – Secrecy and Secret-Key Capacity - Authentication/Authorization for Smart Devices - Transport Encryption – Attack & Fault trees.	13, 14, 15	1
	5.2	**Cryptographic Fundamentals for IoT:** Cryptographic primitives and its role in IoT – Encryption and Decryption – Hashes – Digital Signatures – Random number generation – Cipher suites – key management fundamentals – cryptographic controls built into IoT messaging and communication protocols – IoT Node Authentication.	13, 14, 15	1
	5.4	**Privacy Preservation and Trust Models for IoT:** Concerns in data dissemination – Lightweight and robust schemes for Privacy protection – Trust and Trust models for IoT – self-organizing Things - Preventing unauthorized access.	13, 14, 15	1
	5.5	**Cloud Security for IoT:**Cloud services and IoT – offerings related to IoT from cloud service providers – Cloud IoT security controls – An enterpriseIoT cloud security architecture – New directions in cloud enabled IoT computing.	13, 14, 15	1
			Total	**14**

Recommended Books:

1) Editors: OvidiuVermesan Peter Friess, "*Internet of Things – From Research and Innovation to Market*".
2) N. Ida, "*Sensors, Actuators and Their Interfaces*", Scitech Publishers, 2014.
3) Dr. Guillaume Girardin , Antoine Bonnabel, Dr. Eric Mounier, "*Technologies & Sensors for the Internet of Things Businesses & Market Trends 2014 – 2024*",Yole Development Copyrights, 2014
4) Steve Furber, "*ARM System-on-Chip Architecture*", 2nd Edition, Pearson Education, India ISBN: 9788131708408, 8131708403, 2015
5) Raj Kamal, "*Microcontroller - Architecture Programming Interfacing and System Design*" 2nd Edition, Pearson Education, 2011
6) Joseph Yiu, "*The Definitive Guide to the ARM Cortex-M3*, 2nd Edition, Elsevier Inc. 2010.
7) Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, "*From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence*", 1st Edition, Academic Press, 2014
8) Peter Waher, "*Learning Internet of Things*", PACKT publishing, BIRMINGHAM – MUMBAI
9) Bernd Scholz-Reiter, Florian Michahelles, "*Architecting the Internet of Things*", ISBN 978-3-642-19156-5 e-ISBN 978-3-642-19157-2, Springer

10) Daniel Minoli, "*Building the Internet of Things with IPv6 and MIPv6: The Evolving World of*
   M2M Communications", ISBN: 978-1-118- 47347-4, Willy Publications

11) Stackowiak, R., Licht, A., Mantha, V., Nagode, L.," *Big Data and The Internet of Things Enterprise Information Architecture for A New Age*", Apress, 2015.
12) Dr. John Bates , "*Thingalytics - Smart Big Data Analytics for the Internet of Things*", John Bates, 2015.
13) "*Practical Internet of Things Security (Kindle Edition)*" by Brian Russell, Drew Van Duren.
14) "*Securing the Internet of Things*" Elsevier.
15) "*Security and Privacy in Internet of Things (IoTs): Models, Algorithms, and Implementations*".

Instructional Method and Pedagogy: At the start of course, the course delivery pattern, prerequisite of the subject will be discussed. Lectures will be conducted with the aid of multi-media projector, black board, OHP etc. Attendance is compulsory in lecture and laboratory which carries 40 marks in overall evaluation. One internal exam will be conducted as a part of internal theory evaluation. Assignments based on the course content will be given to the students for each unit and will be evaluated at regular interval evaluation. Surprise tests/Quizzes/Seminar/tutorial will be conducted having a share of 10 marks in the overall internal evaluation. The course includes a laboratory, where students have an opportunity to build an appreciation for the concepts being taught in lectures. Experiments shall be performed in the laboratory related to course contents.

Exp. No	Experiment Details	Ref	Marks
1[CO1,CO2]	Introduction to DHT11 Temperature and Humidity measurement, Ultrasonic Sensor, PIR Motion sensor. Introduction to Actuators (DC Motor, Servo Motor and Relay). Introduction to Bluetooth Technology.	1,2, 3,4	5
2[CO1,CO2]	Outdoor Temperature & Humidity Monitoring using DHT11. Motion Detection using PIR sensor. Distance Measurement using Ultrasonic Sensor. Practical with Servo Motor and Relay. Interfacing HC-05 Bluetooth Device with Arduino, Raspberry Development Board. Home automation using Voice Commands & Bluetooth.	1,2, 3,4	5
3[CO3]	Introduction to NodeMCU (ESP8266-12E). Introduction to NodeMCU firmware. NodeMCU as Server and Client. NodeMCU as an Access Point. Mobile Communication using Sim800 (GSM/GPRS Module) Introduction to various Notification Servers.	1,2, 3,4	5
4[CO3,CO4]	Control of equipment using ESP8266+NODE MCU Webserver. Automatic Phone/Email Notification based on Event trigger using IFTTT. NodeMCU as an Access Point.	1,2, 3,4	5

	Mobile Weather Station using NodeMCU. Home automation using Sim 800 using Mobile Communication.		
5[CO3,CO4, CO5]	Introduction to IOT Cloud Platforms and API TCP /IP/HTTP Protocol Client and Server Communication. Introduction Smart Bridge, ThingSpeak, Google Firebase IOT Cloud . Uploading sensor data to Cloud using API's. Data Visualization, Data Analytics, Plugins, Import & Export Sending and Receiving Data from IOT Cloud using ESP8266 Introduction to MIT App Inventor.	**1,2, 3,4**	**5**
6[CO3,CO4, CO5]	Sending and Receiving Data from IOT Cloud using ESP8266 Uploading Temperature & Humidity data to ThingSpeak Cloud & Ubidots cloud using wifi. Building Mobile Application using MIT App Inventor.	**1,2, 3,4**	**5**
7[CO6]	Prototyping and Building. Use cases: Smart City Smart Water Smart Environment Smart Health (Remote) Smart Waste Management Smart Agriculture Smart Safety Smart Supply Chain & Logistics Smart Manufacturing / Industrial Iot	**1,2, 3,4**	**5**
8[CO6]	Prototyping and Building. Use cases: Smart City Smart Water Smart Environment Smart Health (Remote) Smart Waste Management Smart Agriculture Smart Safety Smart Supply Chain & Logistics Smart Manufacturing / Industrial Iot	**1,2, 3,4**	**5**
	Assessment Marks		**40**

ISE Evaluation: Continuous evaluation of experiments for 40 Marks

MSE Evaluation: Subjective evaluation for 10 Marks based on theory for one hour duration

ESE Evaluation: Subjective evaluation for 20 Marks based on theory for one hour duration

Recommended Books:
1) "*Raspberry Pi IoT Projects: Prototyping Experiments for Makers*" by John C. Shovic.

2) *"Internet of Things with ESP8266"* by Marco Schwartz
3) *"IoT: Building Arduino-Based Projects"* by Brian Russell, Peter Waher, and PradeekaSeneviratne.
4) *"Designing the Internet of Things"* by Adrian McEwen and Hakim Cassimally.

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
OE5	Fundamentals of Computational Intelligence	1	--	2	1	--	1	2
		Examination Scheme						
		ISE		MSE		ESE		Total
		40		10		20		70

Course Overview (Theory):

This open elective course is designed to introduce the concepts of computational intelligence and its application. It is structured to give students an overview of three fundamental topics which form the basis of Computational Intelligence: neural networks, fuzzy logic, natural language processing, and statistics. Students will be able to understand the working of different types of models according to different types of training. Fuzzy logic is included to enable students to design their own fuzzy control systems using all the various concepts taught. They will also learn about the basics and steps involved in Natural Language Processing which can be employed in most applications. To learn about which method fits their data set best, they will be introduced to the application of statistics to computational intelligence. Thus this open elective is focus on inspiration, design, theory, and practical aspects of implementing procedures to solve real-world problems.

The concepts taught in the theory must be implemented in the form of various problem statements in the practical. There will be four experiments based on supervised learning, CNN, Fuzzy controllers and model-fit calculation techniques. Emphasis is given to the mini-project which carries a high weightage. Students are required to implement most of the concepts learned throughout the practical in the mini-project by selecting a suitable problem statement. The mini-project will be graded at two stages. Special emphasis is given to the mini-project at the end of the practical sessions which will be based on computational intelligence.

Pre-requisite Course Codes	Mathematics, Probability ,Programming languages - Java/C++	
Course Outcomes	OE5.1	Identify suitability of different learning types for different scenarios.
	OE5.2	To study Neural Networks and Convolutional Neural Networks
	OE5.3	To design fuzzy controllers for various applications.
	OE5.4	To study Natural Language Processing
	OE5.5	To apply computational intelligence technique to solve real world problems.

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Module No.	Unit No.	Topics	Ref.	Hrs.
1	1	**Introduction to Computational Intelligence** : Concepts	**1,6**	0.5
2	2	**Basics of Artificial Neural Networks and Convolutional Neural Networks**	**1,2, 7,8**	2.5
	2.1	Short History of Neural Networks, Rosenblatt's Neuron, Types of Learning (Supervised, Unsupervised, Reinforcement), Activation Functions.		
	2.2	Basic terminologies and architecture of ANN		
	2.3	Basic architecture of CNN		
3	3	**Fuzzy Controllers**	**1,2, 3,7, 8**	04
	3.1	Crisp Logic, Fuzzy logic, Fuzzy Membership functions and operators		
	3.2	Fuzzy Inference System and its types, Fuzzification ,Defuzzification, Designing Fuzzy logic control systems.		
4	4	**Basics of Natural Language Processing**	**4**	04
	4.1	Basic terminologies and steps involved in NLP		
	4.2	Applications of NLP		
5	5	**Statistics in Computational Intelligence**	**5**	03
	5.1	Calculation of standard deviation, root mean square, mean absolute error etc for measuring the fitness of a model		
			Total	**14**

Exp. No.	Suggested List of Experiments	Ref.	Marks
1	Experiment on Supervised Learning (Back Propagation Neural Network)	**1,2,7,8**	5
2	Experiment on studying different CNN architectures	**1,2**	5
3	Experiment on designing a Fuzzy Controller	**2,3,6,7,8**	5
4	Experiment on measuring fit and error parameters for a model	**5**	5
5	Mini project	**Online Recomm- ended Books**	20
		Assessment Marks	**40**

ISE Evaluation: Continuous evaluation of experiments for 40 Marks

MSE Evaluation: Subjective evaluation for 10 Marks based on theory for one hour duration

ESE Evaluation: Subjective evaluation for 20 Marks based on theory for one hour duration

Recommended Books:

1) Russell Eberhart and Yuhui Shi – "*Computational Intelligence: Concepts to Implementations*" (2007).
2) Fakhreddine Karray and Clarence de Silva – "*Soft Computing and Intelligent Systems Design*" (2004)
3) Andries Engelbrecht – "*Computational Intelligence: an Introduction*" (2007)

4) Ela Kumar – "*Natural Language Processing*" (2013)
5) Peter Bruce and Andrew Bruce – "*Practical Statistics for Data Scientists*" (2017).
6) James M. Keller, Derong Liu, David B. Fogel, "*Fundamentals of Computational Intelligence: NeuralNetworks, Fuzzy Systems, and Evolutionary Computation*", IEEE Press series on Computational Intelligence,Wiley Publication, July 2016.
7) S.N.Sivanandam, S.N.Deepa "*Principles of Soft Computing*" 2nd Edition, Wiley Publication.
8) Samir Roy and Chakraborty, "*Introduction to soft computing*", Pearson Edition.

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	**T**	**P**	**L**	**T**	**P**	**Total**
OE6	**Fundamentals of Data Structures and Algorithms**	1	--	2	1	--	1	2
		Examination Scheme						
		ISE		**MSE**		**ESE**		**Total**
		40		10		20		70

Pre-requisite Course Codes	ES4: Programming Methodology and Data Structures	
After successful completion of the course student will be able to		
Course Outcomes	OE6.1	Implement various operations of nonlinear data structures.
	OE6.2	Apply the concepts of Trees to a given problem.
	OE6.3	Analyze time and space complexity of an algorithm
	OE6.4	Apply divide and conquer strategy to solve problems

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1.1	**Introduction to Data Structures** Introduction, Review of Stack, Queue and Linked List.	**1,2**	**01**
2	2.1	**Searching And sorting:** Searching : Linear Search, Binary Search. Sorting: Insertion sort, Merge sort.	**1,2**	**03**
3	3.1	**Introduction to Algorithms** Algorithm development, Performance analysis, space and time complexity.	**3,4**	**02**
4	4.1	**Growth of function** Big –Oh ,Omega , Theta notation Analysis of insertion sort.	**3,4**	**03**
5	5.1	**Divide and Conquer Approach** Analysis of Merge sort	**3,4**	**01**
6	6.1	**Binary Trees** Representation, Binary Search Tree and its operations, Binary Tree Traversal, AVL Tree, B-tree	**1,2**	**04**
			Total	**14**

Exp. No.	Suggested List of Experiments	Ref.	Marks
1	Implementation of Linked List for a given scenario.	**1,2**	**5**
2	Implementation of Binary Search for a given scenario.	**1,2**	**5**
3	Implementation of Merge Sort for a given scenario.	**1,2,3**	**5**

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4	Implementation of Tree Traversal for a given scenario.	1,2	5
5	Develop an application to explore the uses of an AVL tree	1,2	5
6	Develop Search application using B-Tree.	1,2	5
7	Sorting of 2 lacs elements using Insertion and Merge sort and do the analysis of algorithms.	3,4	10
		Total	**40**

ISE Evaluation: Continuous evaluation of experiments for 40 Marks

MSE Evaluation: Subjective evaluation for 10 Marks based on theory for one hour duration

ESE Evaluation: Subjective evaluation for 20 Marks based on theory for one hour duration

Recommended Books:

1) *"Data Structures A Psedocode Approach with C"*, Richard F. Gilberg & Behrouz A. Forouzan, second edition, CENGAGE Learning.
2) *"Introduction to Data Structure and its Applications"*, Jean-Paul Tremblay, P. G. Sorenson.
3) Thomas H.Cormen, Charles E. Leiserson, Ronald L Rivest, Clifford Stein, *"Introduction to Algorithms"*, 3rd Edition, MIT Press, Massachusetts, 2009.
4) Horowitz E, Sahni S andS.Rajasekaran, *"Fundamentals of Computer Algorithms"*, Second Edition, Galgotia Publications, New Delhi, 2010.

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
OE7	Software Testing	1	--	2	1	--	1	2
		Examination Scheme						
		ISE		MSE		ESE		Total
		40		10		20		70

Pre-requisite Course Codes	---	
At the end of the lab students will be able to		
Course Outcomes	OE7.1	Analyze the principles in software testing to prevent & remove bugs.
	OE7.2	Design effective test cases suitable in testing.
	OE7.3	Describe the variety of ways to test software and indicate the trade-offs between various testing techniques.
	OE7.4	Implement various test cases.
	OE7.5	Apply the software testing techniques in commercial environments.
	OE7.6	Able to use software testing methods and modern software testing tools for their testing projects.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction to Software Testing**	2	2
	1.1	Software Quality		
	1.2	Verification and Validation		
	1.3	Failure, Error, Fault and Defect		
	1.4	Test Case		
	1.5	Test levels		
	1.6	Software Testing Life Cycle		
2.		**Black-Box Testing**	1	4
	2.1	Boundary Value Analysis		
	2.2	Equivalence class testing		
	2.3	State table based testing		
	2.4	Cause-effect graphing based testing		
	2.5	Error guessing		
3.		**White Box Testing**	1	4
	3.1	Need of White box Testing		
	3.2	Logic coverage criteria		
	3.3	Basis path testing		
	3.4	Graph matrices		
	3.5	Loop testing		
	3.6	Data flow testing		
	3.7	Mutation testing		

4.		LEVELS OF TESTING	3	4
	4.1	Unit testing		
	4.2	Integration Testing		
	4.3	System Testing		
	4.4	Acceptance testing		
	4.5	Performance testing		
	4.6	Regression Testing		
	4.7	Ad-hoc testing,Alpha, Beta Tests		
		Total		**14**

Exp. No.	Suggested List of Experiments	Ref.	Marks
1	Write the test cases for any known application.	1	5
2	Create a test plan document for any application.	1	5
3	Design Test case using boundary value analysis.	1	5
4	Design a test cases using equivalent class partitioning.	1	5
5	Study of testing tool, Win runner.	2,3	5
6	Study of test management tool, Test Director.	2,3	5
7	Test Automation using Selenium IDE.	2,3	5
8	Test Automation using Selenium Web driver.	2,3	5
	Total		**40**

ISE Evaluation: Continuous evaluation of experiments for 40 Marks

MSE Evaluation: Subjective evaluation for 10 Marks based on theory for one hour duration

ESE Evaluation: Subjective evaluation for 20 Marks based on theory for one hour duration

Recommended Books:

1) NareshChauhan, "*Software Testing Principles and Practices*", Oxford Higher Education.
2) KshirasagarNaik and PriyadarshiTripathy, "*Software Testing and quality assurance theory and practice*", Wiley Publication.
3) Srinivasan Desikan and Gopalaswamy Ramesh, "*Software Testing – Principles and Practices"*, Pearson education, 2006.

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
OE8	Database Management Systems	1	-	2	1	--	1	2
		Examination Scheme						
		ISE		MSE		ESE		Total
		40		10		20		70

Pre-requisite Course Codes	---

At the end of the course students will be able to

Course Outcomes	OE8.1	Design a database for real world system,choose real world problem and map it to the solution using database techniques.
	OE8.2	Construct a database using SQL.
	OE8.3	Create normalized database using functional dependencies.
	OE8.4	Analyze the effect of transaction over the database.
	OE8.5	Build secure and normalize database using SQL constructs.
	OE8.6	Apply the connectivity techniques of database.

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1.1	**Introduction Database Concepts and ER Modeling** Characteristics of databases, File system V/s Database system, Users of Database system, DBMS system architecture, Database Administrator.	1,2,3	2
	1.2	Introduction to ER model, Benefits of Data Modeling, Types of Models, The Entity-Relationship (ER) Model, Generalization, Specialization and Aggregation, Mapping of ER to Relational model.		2
2	2.1	**SQL** Overview of SQL, Data Definition Commands, Set operations, aggregate function, null values, Data Manipulation commands, Data Control commands, Views in SQL, Trigger.	1,2	5
3	3.1	**Normalization** Design guidelines for relational schema, Function dependencies, Normal Forms- 1NF, 2 NF, 3NF.	1,2,3	3
4	4.1	**Transactions Management**: Transaction concept, Transaction states, ACID properties, Implementation of atomicity and durability.	1,2,4	2
			Total	14

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Exp. No.	Suggested List of Experiments	Ref.	Marks
1	Identify the real world problem which can be mapped to the database using database concept. Design E-R model for the same.	1	5
2	Perform database administration DCL commands.	1,2	5
3	Build a database with related data using SQL.	2	5
4	Perform Data Manipulation using SQL.	2	5
5	Perform various nested queries on database.	2	5
6	Perform TCL operations over database.	2	5
7	Examine integrity of database using triggers.	2	5
8	Perform database connectivity using JDBC on a table.	1,2	5
		Total	**40**

ISE Evaluation: Continuous evaluation of experiments for 40 Marks

MSE Evaluation: Subjective evaluation for 10 Marks based on theory for one hour duration

ESE Evaluation: Subjective evaluation for 20 Marks based on theory for one hour duration

Recommended Books:

1) Korth, Slberchatz, Sudarshan, "*Database System Concepts*", 7th Edition, McGraw – Hill, 2010.
2) Elmasri and Navathe, "*Fundamentals of Database Systems*", 5th Edition, PEARSON Education, 2015.
3) G. K. Gupta, "*Database Management Systems*", McGraw – Hill, 2011.
4) Peter Rob and Carlos Coronel, "*Database Systems Design, Implementation and Management*", 8th Edition, Thomson Learning, 2007.
5) Sharaman Shah, "*Oracle for Professional*", SPD, 2008.
6) Dr.P.S.Deshpande , " *SQL &PLSQL for oracle*" Black Book, 2007.

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
IT81	Enterprise Resource Planning	3	1	--	3	1	--	4
		Examination Scheme						
		ISE		MSE		ESE		Total
		20		20		60		100

Pre-requisite Course Codes	IT43 : Database Management Systems
	IT51 : Software Engineering

After successful completion of the course, student will be able to

Course Outcomes	IT81.1	Examine different processes of the organization and the relationship among all processes
	IT81.2	Determine the support of ERP data in CRM/SCM/Etc.
	IT81.3	Discuss typical functionalities in an ERP system
	IT81.4	Elaborate the activities done during ERP implementation
	IT81.5	Discuss case studies in real world scenario to assure ERP benefits

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction to ERP**	1,2	6
	1.1	Enterprise – An Overview Integrated Management Information		
	1.2	Business Modeling		
	1.3	Integrated Data Model		
2		**ERP and Related Technologies**	1,2	10
	2.1	Business Processing Reengineering(BPR)		
	2.2	Online Analytical Processing OLAP		
	2.3	Supply Chain Management(SCM)		
	2.4	Customer Relationship Management(CRM)		
	2.5	Geographical information System(GIS)		
	2.6	MIS Management Information System, DSS- Decision Support System, EIS Executive Information System		
3		**ERP architecture**	3,4	6
	3.1	ERP Architecture : Technical aspects		
	3.2	Types of ERP architecture		
	3.3	ERP platforms		
	3.4	Emerging trends and Future of ERP		
4		**ERP – Some key Modules**	2	8
	4.1	Finance		
	4.2	Plant Maintenance		
	4.3	Quality Management		
	4.4	Materials Management		

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5		**ERP Implementation**	2,3,5	6
	5.1	Pre-evaluation Screening		
	5.2	Package Evaluation		
	5.3	ERP Transition Strategies		
	5.4	ERP Implementation process		
	5.5	Data Migration		
	5.6	Change management in ERP Life Cycle		
	5.7	Post-implementation (Maintenance model)		
6		**Case Studies & Benefits of ERP**	2	6
	6.1	Case study Discussion		
	6.2	Quantifiable benefits		
	6.3	The intangible benefits of ERP		
	6.4	Risks of ERP		
			Total	42

Recommended Books:

1) Alexis Leon*,"Enterprise Resource Planning",* 3rd Edition, Tata McGraw Hill, 2014 .
2) Alexis Leon *,"Enterprise Resource Planning"* (Demystified), Tata McGraw Hill,1999.
3) D. P. Goyal ,*"Enterprise Resource Planning",* 1st Edition, Tata McGraw Hill, 2011.
4) Ravi Shankar, S.Jaiswal, *"Enterprise Resource Planning",* 1st Edition, Galgotia Publication Pvt. Ltd, 1999.
5) Annetta Cleto and Dane Franklin, *"Guide to Planning ERP Application",* McGraw -Hill, 1997.

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	**T**	**P**	**L**	**T**	**P**	**Total**
IT82	**User Experience Design**	**3**	**1**	**-**	**3**	**1**	**-**	**4**
		Examination Scheme						
		ISE		**MSE**	**ESE**		**Total**	
		20		**20**	**60**		**100**	

Pre-requisite Course Codes	ITL35:Web Programming Lab
After successful completion of the course, student will be able to	

Course Outcomes	IT82.1	Paraphrase UI and UX design life cycle.
	IT82.2	Analyze UX design process for users.
	IT82.3	Analyze various parameters for design process.
	IT82.4	Apply design thinking to model the prototype.
	IT82.5	Evaluateuser experiences using different UX evaluation techniques.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction:**	**7,8**	**8**
	1.1	Introduction to Human Machine Interface, Hardware, software and operating environment to use HMI in various fields.		
	1.2	The psychopathology of everyday things – complexity of modern devices; human-centered design; fundamental principles of interaction		
	1.3	Psychology of everyday actions- how people do things; the seven stages of action and three levels of processing; human error.		
2		**UX Design:**	**1,5,6**	**6**
	2.1	What is UX, Ubiquitous interaction		
	2.2	Emerging desire for usability, From usability to user experience		
	2.3	Emotional impact as part of the user experience, User experience needs a business case.		
3		**The UX design lifecycle Template :**	**1**	**4**
	3.1	Introduction, A UX process lifecycle template		
	3.2	Choosing a process instance for your project.		
4		**The UX design Process:**	**1,2,3**	**8**
	4.1	Introduction, The system concept statement, User work activity gathering		
	4.2	Look for emotional aspects of work practice, Abridged contextual inquiry process		
	4.3	Data - driven vs. model - driven inquiry		
	4.4	Contextual Analysis, Extracting Interaction Design requirements, Constructing Design, Information Models		

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5		**Design Thinking :**	1,3	10
	5.1	Introduction, Design paradigms, Design thinking, Design perspectives, User personas, Ideation. Sketching, Mental models.		
	5.2	Wireframes and Prototyping: Wireframes, Depth and breadth of a prototype, Fidelity of prototypes, Interactivity of prototypes,		
	5.3	Software tools in prototypes		
6		**UX Evaluation:**	1,2	6
	6.1	UX goals, UX target tables, UX metrics		
	6.2	UX Evaluation Techniques: Formative Vs Summative evaluation and its types, Types of evaluation data		
	6.3	Data collection techniques, Variations in formative evaluation results.		
			Total	**42**

Recommended Books:

1) Rex Hartson and PardhaPyla,*"The UX Book"*, 2nd Edition, MK publications, 2012.
2) Jesmond Allen and James Chudley ,*"Smashing UX Design"*, 1st Edition, John Wiley and sons, 2012.
3) Steve krug,*"Don't make me think",* 3rd Edition, New Riders,2015.
4) Russ Unger and Carolyn Chandler,*"A Project Guide to UX Design",*2nd Edition, Peachpit Press, 2009.
5) Jesse James Garrett,*"The Elements of User Experience",* 2nd Edition , AIGA, New Riders, 2010.
6) Donald A. Norman,*"The design of everyday things",* 1st Edition, Basic books, 2013.
7) Kalbande,Kanade,Iyer*,"Galitz's Human Machine Interaction",* Wiley Publications, 2015.
8) Wilbert Galitz,*"The Essential Guide to User Interface Design",* Second Edition, Wiley Publications, 2002.

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
ITL81	Enterprise Resource Planning Lab	--	--	2	--	--	2	1
		Examination Scheme						
		ISE		MSE		ESE		Total
		40		--		--		40

| Pre-requisite Course Codes | ITC43 : Database Management Systems
ITC51 : Software Engineering |
|---|---|
| After successful completion of the course, student will be able to | |

Course Outcomes	ITL81.1	Demonstrate knowledge of SAP / Oracle Apps/Etc.
	ITL81.2	Examine systematically the planning mechanisms in an enterprise for ERP implementation.
	ITL81.3	Determine ERP interface support to CRM/SCM and its benefits.
	ITL81.4	Support rendered by ERP solutions in effective decision making.
	ITL81.5	Elaborate customization procedure during ERP implementation.

Exp No.	Suggested List of Experiments	Ref.	Marks
1.	Review an ERP tool, Write salient points and state how seamless integration is done.	1,8,9	5
2.	Select business organization for ERP and analyze its process.	1,2	5
3.	CRM tool- Use free download of any CRM tool. Analyze its benefits during client meeting.	3,4	5
4.	To implement sample SCM process Write relational schemas to link data from different modules.	5,6	5
5.	Import/Export data into ERP	10	5
6.	Create Reports using ERP data for strategic decision making	10	5
7.	Customization during ERP implementation.	7,10	5
8.	Case-study presentation – ERP application	7	5
		Total	40

Recommended Books:

1) Alexis Leon,"*Enterprise Resource Planning*", 3rd Edition, Tata McGraw Hill, 2014.
2) Alexis Leon ,"*Enterprise Resource Planning*" (Demystified), Tata McGraw Hill,1999.
3) https://www.sugarcrm.com/
4) "*CRM at the speed of Light : Social CRM strategies, tools and techniques for engaging your customers*" : 4th Edition by Paul Greenberg , McGraw Hill, 2009.
5) Janat Shah, "*Supply Chain Management*", 2nd Edition, 2016.
6) David Burt, "*Supply Management*", McGraw Hill Publications, 8th Edition, 2010.
7) Wallace, T. F., Kremzar, M. H. 2001, "*ERP: Making It Happen*", John Wiley.
8) www.sap.com
9) www.oracle.com
10) Download tool :https://erpinfo.org/erplab/ or https://github.com/lucklab/erplab/releases/tag/ 7.0.0.
11) tool manual: https://github.com/lucklab/erplab/wiki/Manual

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
ITL82	User Experience Design Lab	--	--	2	--	--	2	1
		Examination Scheme						
		ISE		MSE		ESE		Total
		40		--		--		40

Pre-requisite Course Codes		ITL35 : Web Programming Lab
After successful completion of the course, student will be able to		
Course Outcomes	ITL82.1	Demonstrate the use of UX tools.
	ITL82.2	Create real life application with end-to-end understanding of User experience practices.
	ITL82.3	Develop map based UI for social and technical task.
	ITL82.4	Evaluate the design of the application using User Experience principles

Exp No.	Suggested List of Experiments	Ref.	Marks
1	To Studyof open source UX tools (Justinmind Prototype, Pidoco, Figma, Marvel Prototype) and create UX design for a given problem definition	1,2,3,4	5
2	Design UI for Web application : Hint: Design Web UI for kinder garden student to teach mathematics.	1,2,3,4	5
3	Design UI for Mobile application : Hint: Design MobileUI for kinder garden student to teach mathematics for Urban Sector.	1,2,3,4	5
4	Design map based UI : Design a Map based UI for property (real estate) management. Implement them localization framework for localizable UI.	1,2,3,4	5
5	Design UI for Mechanical machines: Design User Interfaces for Remote Control of Manufacturing Systems	1,2,3,4	5
6	Design UI for Electronics appliances: Design UI for Smart Phone or Smart TV with localization features.	1,2,3,4	5
7	Design UI for any differently abled users	1,2,3,4	5
8	Design UI for analysis of number of children suffering from juvenile diabetic children in India. The design aims at providing solutions for improving quality treatment and making the treatment affordable.	1,2,3,4	5
		Total	40

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Note: The main outcome of the above experiments is to make the final design usable and it should be deliverable to the user. The experiments are set to practice the UX tools with which the above experiments can be designed and evaluated using User Interface and User Experience guidelines.

Recommended Books:

1) Hartson and PardhaPyla,*"The UX Book"*, Second Edition, MK publications, 2012.
2) Russ Unger and Carolyn Chandler,*"A Project Guide to UX Design",* 2nd Edition, Peachpit Press, 2009.
3) Kalbande, Kanade,Iyer*,"Galitz's Human Machine Interaction",*Wiley Publications, 2015.
4) Jesse James Garrett,*"The Elements of User Experience",* 2nd Edition , AIGA, New Riders, 2010.

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
HSS81	Technology Entrepreneurship Lab	--	--	02	--	--	01	01
		Examination Scheme						
		ISE		MSE		ESE		Total
		40		--		--		40

Pre-requisite Course Codes	
After successful completion of the course, student will be able to	

	HSS81.1	Identify problems worth solving
	HSS81.2	Craft value proposition
Course Outcomes	HSS81.3	Prepare B-Plan
	HSS81.4	Draft Patent
	HSS81.5	Register virtual company

Expt. No.	Suggested List of Experiments	Ref.	Marks
1	**Opportunity Discovery** 1.1 Self-discovery 1.2 Effectuation Principle 1.3 Identification of problem worth solving 1.4 Looking for solutions 1.5 Present the problem Assignment Submission : Effectuation case study	1	8
2	**Value Proposition Canvas and Business Model** 2.1 Craft your value proposition 2.2 Presentation of Value Proposition Canvas 2.3 Business Model and Lean Approach (Finance, Marketing, Operations) 2.4 Presentation of Lean Canvas Assignment Submission : Presentation of Value Proposition Canvas	2,3	8
3	**Business Plan (4 hours)** 3.1 Creation of Business Plan Assignment Submission : Presentation of Lean Canvas	4	8
4	**Intellectual Property Rights** 4.1 Trademark 4.2 Copyright 4.3 Design 4.4 Patent Assignment Submission : Patent Draft and registration form for Trademark, Copyright, Design and Patent	5	8

5	**Company Formation** 5.1 Promoters, Capital, Shareholders 5.2 Directors, DIN 5.3 Company Name, Registrations 5.4 Branding Assignment Submission : Virtual Company registration	6	8
	Five Assignments Marks		**40**

Recommended Books:

1) "*Elements of Entrepreneurial Expertise (New Horizons in Entrepreneurship Series)*" by Saras Sarasvathym, Publisher : Edward Elgar Publishing.
2) "*Business Model Generation : A Handbook for Visionaries, Game Changers, and Challengers*" by Alexander Osterwalder.
3) "*Value Proposition Design: How to create Products and Services Customers Want*" by Alex Osterwalder, Yves Pigneur, Greg Bernarda, Alan Smith, Trish Papadakos.
4) "*Writing Winning Business Plans*" by Garrett Sutton. Publisher: RDA Press.
5) "*Patent Law*" by P. Narayanan. Publisher :Eastern Law House, 1975.
6) "*Company Law Procedures*" by M.C. Bhandari, Lexi Nexis, 2018.

ABL 5: Financial Planning, Taxation Policies and Investment

Financial Planning: It is possible to manage income more effectively through financial planning. Managing income helps to understand how much money is required for tax payments, other expenditures and savings. It increases cash flows by carefully monitoring the spending patterns and expenses. Knowledge of comprehensive financial planning will help students to make right financial decisions in their life. It gives guidance in helping choose the right types of investments to fit needs, personality, and goals of their life. In this activity students need to prepare the financial plan for their life.

Taxation Policies: Taxes are levied in almost every country of the world, primarily to raise revenue for government expenditures, although they serve other purposes as well. The simple fact in economics is that there are certain common public goods and public needs that require some form of government and regulation to provide or promote. Taxation is the way to pay for these common goods. In this activity student will learn various types of taxes like Income tax, Corporate tax, Capital gains, Property tax, Inheritance and Sales tax.

Investments: Investments are important because in today's world, just earning money is not enough. But that may not be adequate to lead a comfortable lifestyle or fulfil our dreams and goals. Money lying idle in the bank account is an opportunity lost. Therefore students should have a knowledge to invest money smartly to get good returns out of it. This activity will give insight to the students about investment in the form of Stocks, Mutual Funds, Fixed Deposits, Recurring Deposit, Public Provident Fund, **Employee Provident Fund and National Saving Schemes.**

Methodology: Guest lectures by professionals shall be arranged on Financial Planning, Taxation Policies and Investments. At least one session on each topic shall be taken. Assessment shall be based on performance in following activities:
1. Prepare financial plan
2. Filling of 'Income Tax Return' (Perquisite: Pan Card (if not available, student should apply for pan card)
3. Prepare investment plan

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
ITP81	Category I :Major Project I	--	--	10	--	--	5	5
		Examination Scheme						
		ISE		MSE		ESE		Total
		Phase-I:40 Phase-II:40		--		20		100

The main intention of Major Project is to enable students to apply the knowledge and skills learned in various courses to solve/implement predefined practical problem mainly addressing the issues of society, an industry or a research. These students have already undergone project assignment in their pre-final year in Action Research Plan I & Action Research Plan II courses. Therefore Major Project work may be based on the knowledge gained in the courses OR may be beyond the scope of curriculum of courses taken OR may be extension of the work done in Action Research Plan I and Action Research Plan II courses in pre-final year. The project area may be selected in which the student intend to do further education and/or may be either intending to have employment or self-employment. However thrust should be

● Learning additional skills, computational techniques etc.
● Development of ability to define, design, analyze and implement solution to the problem.
● Deliverable in the form of working prototype of hardware/software OR research publication in a reputed Conference/Journal OR patent
● Learn the behavioral science by working in a group.

Students of final year are categorized as Category I (Internship) and Category II (Non-Internship) students. In final year these students groups will have to execute Major Projects. Execution and evaluation of Major Project will be done as Major Project I and Major Project IIin respective semesters of Category I &Category II students. If a Guide and a group of students of a particular Major Project wish then they can continue the work done as Major Project I and Major Project IIin respective semesters as a part of Major Project. Execution and evaluation of Major Project will be done as per the Project Process developed at Institute level**.** The details of this process are available in Project Log Book.

At the end of Sem VI; students are required to finalize whether they wish to opt Category I (Internship) OR Category II (Non-Internship). Since these are separate group of students; students are required to form a Project Group within the category they have opted for. In order for the smooth execution and evaluation of Major Project; formation of a Project Group from students belonging to different categories will not be allowed at any circumstances. However in order to promote execution of interdisciplinary project; students from different departments but from the same category may execute the Major Project after the approval/agreement from respective Guides.

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Evaluation of these Project Groups will however be done on the basis of the work assigned to them OR their project objectives. Project group of maximum three students will be allowed. Each project group will be completing a comprehensive project work based on the knowledge acquired from the courses studied. Each group will be assigned one faculty as a Guide as per Department policies.

The project work will be internally evaluated in Phases (Phase I and Phase II) by the Expert Groups in the Department consisting of Guide and two OR more than two domain expert faculties based on Scheme of examination for ISE Marks and on the basis of rubrics defined for each Phase of evaluation as per following but not limited to:
- Scope and objectives of the project work.
- Extensive Literature survey.
- Ethics and Societal Aspects
- Planning and Progress of the work (Continuous assessment).
- Design, implementation, and analysis of the project work
- Results, conclusions and future scope
- Report in prescribed format

In order to keep proper evaluation record of the progress of project in the department; each Project Group should submit soft copy of report (approved by respective Guide) in the prescribed format of the Department before each phase of evaluation for ISE marks and one hard copy of the Report duly signed by respective Guide in prescribed format for ESE marks to Project co-ordinator.

For ESE Marks; an approved external examiner and internal examiner appointed by the head of the department together will assess the Major Project during oral examination. The oral examination is a presentation by the group members on the project along with demonstration of the work done. Each individual student should be assessed for his/her contribution, understanding and knowledge gained, the rubrics defined by department and Report in prescribed format for the awards of ISE and ESE marks.

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
ITP71	Category I : Major Project II	--	--	10	--	--	5	5
		Examination Scheme						
		ISE		MSE	ESE		Total	
		Phase-III:40 Phase-IV:40		--	20		100	

The final year students have already under gone first stage of Major Project I and if project guide approves the continuation of same project then students can do so. Otherwise this project is considered as a separate project and students need to do literature survey, define problem, title of the project and objectives of project.

The project work will be internally evaluated in Phases (Phase III and Phase IV) by the Expert Groups in the Department consisting of Guide and two OR more than two domain expert faculties based on Scheme of examination for ISE Marks. There will be Technical Paper Presentation (TPP) event conducted by R&D Cell and Project Exhibition (PE) event conducted by respective Departments as per the academic time table. Participation in these activities is mandatory. After evaluation Winners will be declared from TPP and PE events separately as per the rubrics, rules and regulations framed by R&D Cell and Department respectively.

In order to keep proper evaluation record of the progress of project in the department; each Project Group should submit soft copy of report (approved by respective Guide) in the prescribed format of the Department before each phase of evaluation for ISE marks and one hard copy of the Report duly signed by respective Guide in prescribed format for ESE marks to Project co-ordinator.

The department should keep proper evaluation record of the progress of project and at the end of the semester it should be assessed for awarding ISE marks. The ISE Marks should be examined by approved internal faculty appointed by the head of Department on the basis of rubrics defined for each Phase of evaluation as per following but not limited to:
- Scope and objectives of the project work.*
- Extensive Literature survey.*
- Ethics and Societal Aspects
- Planning and Progress of the work (Continuous assessment)
- Design, implementation, and analysis of the project work.
- Results, conclusions and future scope.
- Report in prescribed format.
(*NOT required if Major Project II is not in continuation of Major Project I)

For ESE Marks; an approved external examiner and internal examiner appointed by the head of the department together will assess the Major Project during oral examination. The oral examination is a presentation by the group members on the project along with demonstration of the work done.

Each individual student should be assessed for his/her contribution, understanding and knowledge gained and the rubrics defined by department for awarding ISE and ESE marks.

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	**T**	**P**	**L**	**T**	**P**	**Total**
ITP71	**Category II : Major Project I**	--	--	10	--	--	5	5
		Examination Scheme						
		ISE		**MSE**	**ESE**	**Total**		
		Phase-I:40 Phase-II:40		--	20	100		

The main intention of Major Project is to enable students to apply the knowledge and skills learned in various courses to solve/implement predefined practical problem mainly addressing the issues of society, an industry or a research. These students have already undergone project assignment in their pre-final year in Action Research Plan I & Action Research Plan II courses. Therefore Major Project work may be based on the knowledge gained in the courses OR may be beyond the scope of curriculum of courses taken OR may be extension of the work done in Action Research Plan I and Action Research Plan II courses in pre-final year. The project area may be selected in which the student intend to do further education and/or may be either intending to have employment or self-employment. However thrust should be

- Learning additional skills, computational techniques etc.
- Development of ability to define, design, analyze and implement solution to the problem.
- Deliverable in the form of working prototype of hardware/software OR research publication in a reputed Conference/Journal OR patent
- Learn the behavioral science by working in a group.

Students of final year are categorized as Category I (Internship) and Category II (Non-Internship) students. In final year these students groups will have to execute Major Projects. Execution and evaluation of Major Project will be done as Major Project I and Major Project IIin respective semesters of Category I &Category II students. If a Guide and a group of students of a particular Major Project wish then they can continue the work done as Major Project I and Major Project IIin respective semesters as a part of Major Project. Execution and evaluation of Major Project will be done as per the Project Process developed at Institute level**.** The details of this process are available in Project Log Book.

At the end of Sem VI; students are required to finalize whether they wish to opt Category I (Internship) OR Category II (Non-Internship). Since these are separate group of students; students are required to form a Project Group within the category they have opted for. In order for the smooth execution and evaluation of Major Project; formation of a Project Group from students belonging to different categories will not be allowed at any circumstances. However in order to promote execution of interdisciplinary project; students from different departments but from the same category may execute the Major Project after the approval/agreement from respective Guides.

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Evaluation of these Project Groups will however be done on the basis of the work assigned to them OR their project objectives. Project group of maximum three students will be allowed. Each project group will be completing a comprehensive project work based on the knowledge acquired from the courses studied. Each group will be assigned one faculty as a Guide as per Department policies.

The project work will be internally evaluated in Phases (Phase I and Phase II) by the Expert Groups in the Department consisting of Guide and two OR more than two domain expert faculties based on Scheme of examination for ISE Marks and on the basis of rubrics defined for each Phase of evaluation as per following but not limited to:
- Scope and objectives of the project work.
- Extensive Literature survey.
- Ethics and Societal Aspects
- Planning and Progress of the work (Continuous assessment).
- Design, implementation, and analysis of the project work
- Results, conclusions and future scope
- Report in prescribed format

In order to keep proper evaluation record of the progress of project in the department; each Project Group should submit soft copy of report (approved by respective Guide) in the prescribed format of the Department before each phase of evaluation for ISE marks and one hard copy of the Report duly signed by respective Guide in prescribed format for ESE marks to Project coordinator.

For ESE Marks; an approved external examiner and internal examiner appointed by the head of the department together will assess the Major Project during oral examination. The oral examination is a presentation by the group members on the project along with demonstration of the work done. Each individual student should be assessed for his/her contribution, understanding and knowledge gained, the rubrics defined by department and Report in prescribed format for the awards of ISE and ESE marks.

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	**T**	**P**	**L**	**T**	**P**	**Total**
ITP81	**Category II: Major Project II**	--	--	10	--	--	5	5
		Examination Scheme						
		ISE		**MSE**	**ESE**		**Total**	
		Phase-III:40 Phase-IV:40		--	20		100	

The final year students have already under gone first stage of Major Project I OR Major Project II work in their respective semesters and in this semester students are expected to continue the project work of stage I then they need to separately carry literature survey, define problem, title of the project and objectives of project.

The project work will be internally evaluated in Phases (Phase III and Phase IV) by the Expert Groups in the Department consisting of Guide and two OR more than two domain expert faculties based on Scheme of examination for ISE Marks. There will be Technical Paper Presentation (TPP) event conducted by R&D Cell and Project Exhibition (PE) event conducted by respective Departments as per the academic time table. Participation in these activities is mandatory. After evaluation Winners will be declared from TPP and PE events separately as per the rubrics, rules and regulations framed by R&D Cell and Department respectively however ISE marks are not allotted for these activities. In order to keep proper evaluation record of the progress of project in the department; each BE Project Group should submit soft copy of report (approved by respective Guide) in the prescribed format of the Department before each phase of evaluation for ISE marks and one hard copy of the Report duly signed by respective Guide in prescribed format for ESE marks to Project co-ordinator.

The department should keep proper evaluation record of the progress of project and at the end of the semester it should be assessed for awarding ISE marks. The ISE Marks should be examined by approved internal faculty appointed by the head of Department on the basis of rubrics defined for each Phase of evaluation as per following but not limited to:
● Scope and objectives of the project work.*
● Extensive Literature survey.*
● Ethics and Societal Aspects
● Planning and Progress of the work (Continuous assessment)
● Design, implementation, and analysis of the project work.
● Results, conclusions and future scope.
● Report in prescribed format.
(*NOT required if Major Project II is not in continuation of Major Project I)

For ESE Marks; an approved external examiner and internal examiner appointed by the head of the institute together will assess the Major Project during oral examination. The oral examination is a presentation by the group members on the project along with demonstration of the work done.
Each individual student should be assessed for his/her contribution, understanding and knowledge gained and the rubrics defined by department for awarding ISE and ESE marks.