Shri Guru Gobind Singhji Institute of Engineering and Technology Nanded

(An Autonomous Institute of Government of Maharashtra)

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उत्कृष्ट तंत्र ज्ञानार्थं जनशक्तै शिक्षणं

Academic Curriculum

M.Tech. (Artificial Intelligence)

Academic Year- 2020-21

Department of Electronics and Telecommunication Engineering

16/08/2020

Program Educational Objectives (PEOs)

PEO I: To study the Visual Data analytics and Signal Processing and develop proficiency in computational methods for advanced modeling and simulation (preparation).

PEO II: To study Machine Learning systems, Artificial Neural Network, Deep Learning concepts, knowledge-based systems, and to design Computer Vision systems (Core competence).

PEO III: To study and understand the state of art in the recent areas of research in intelligent information retrieval, multimedia, natural language Processing, Bio image analytics, Robotics, Speech processing, Data Mining, GPU Architecture, and programming (Breadth).

PEO IV: Provide academic environment aware of excellence, leadership, and ethical codes to students; and teach them lifelong learning skills including research component needed for successful professional career (Learning environment).

Program Outcomes (POs)

Engineering Graduates will be able to:

PO 1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

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

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

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

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

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

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

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

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

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

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

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

Program Specific Outcomes (PSOs)

PSO1. Model and simulate knowledge-based systems to conduct experiments and analyze the performance using modern tools.

PSO2. To meet realistic constraints like economic, social, environmental, ethical, health and safety of stakeholders by implementing Signal/Image Processing, Machine Learning, Neural Network and Deep learning algorithms and their realization using Computer Vision System knowledge.

PSO3. Engage in society need based innovations and contribute to make in India by gaining awareness of IPRs, Finance, Economics and Entrepreneurship etc in the field of Artificial Intelligence.

Correlation Matrix (Correlation between the PEOs and the POs)

PO/PSO PEO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
PEO I	√	√	√	√	√								√	√	
PEO II	√			√	√		√						√	√	
PEO III	√	√		√		√			√		√				√
PEO IV	√	√	√			√			√	√	√	√		√	√

Note: The cells filled in with √ indicate the fulfillment /correlation of the concerned PEO with the PO.

Shri Guru Gobind Singhji Institute of Engineering and Technology, Nanded
(An Autonomous Institute of Government of Maharashtra)
M. Tech. (Artificial Intelligence)
(Effective from Academic Year 2020-21)

Structure of Curriculum

Semester- I

Sr No	Course Type/ Code	Course Name	Teaching Scheme			Credits
			L	T	P	
1	Core 1 (PCC-AI-501)	Artificial Neural Network and Applications	3	0	2	4
2	Core 2 (PCC-AI-502)	Digital Image and Video Processing	3	0	2	4
3	Core 3 (PCC-AI-503)	Statistical Machine Learning	3	0	2	4
4	Programme Specific Elective-I (PEC-AI-504 to 512)	Students can register for any one course offered by the Department from the list given below.	3	0	2	4
		504 Advanced Digital Signal Processing				
		505 Intelligent Information Retrieval				
		506 Multimedia System Applications				
		507 Cyber Security				
		508 Speech Processing				
		509 Big Data Analytics				
		510 Embedded System Design				
		511 GPU Architecture and Programming				
		512 Data Structure and Algorithm				
5	Mandatory Credit (MCC-590)	Research Methodology and IPR	2	0	0	2
6	Mandatory Audit (MAC-591)	English for Research Paper Writing	2	0	0	-
		Total	**16**	**0**	8	**14**

Semester- II

Sr No	Course Type/ Code	Course Name	Teaching Scheme			Credits
			L	T	P	
1	Core 4 (PCC-AI-513)	Deep Learning	3	0	2	4
2	Core 5 (PCC-AI-514)	Natural Language Processing	3	0	2	4
3	Core 6 (PCC-AI-515)	Intelligent System	3	0	2	4
4	Program Specific Elective-II (PEC-AI-516 to 523)	Students can register for any one course offered by the Department from the list given below.	3	0	2	4
		516 Data Warehousing and Data Mining				
		517 Computer Vision				
		518 Wavelets and Applications				
		519 Quantum Computing				
		520 IoT and Applications				
		521 Soft Computing and Applications				
		522 Bio Image Analytics				
		523 Foundation of Cognitive Robotics				

Sr No	Course Type/ Code	Course Name		Teaching Scheme			Credits
				L	T	P	
5	Open Elective (OEC-801 to 806)	Students can register for any one course offered by the institute from the list given below.		3	0	0	3
		801	Business Analytics				
		802	Industrial Safety				
		803	Operation Research				
		804	Cost Management of Engineering Project				
		805	Composite Material				
		806	Waste to Energy				
6	Seminar/Mini Project (SEM-AI-524)	Seminar/Mini Project		0	0	4	2
7	Audit (AUD-901 to 908)	Students can register for any one course offered by the institute from the list given below.		2	0	0	-
		901	Project Management				
		902	Disaster Management				
		903	Sanskrit for Technical Knowledge				
		904	Value Education				
		905	Constitution of India				
		906	Pedagogy Studies				
		907	Stress Management by Yoga				
		908	Personality Development through Life Enlightenment Skills				
Total				17	0	12	17
Semester- III							
1	Dissertation (DIS-AI-601)	Dissertation Phase-I		0	0	28	14
Semester- IV							
1	Dissertation (DIS-AI-602)	Dissertation Phase-II		0	0	28	14

Semester-I

PCC-AI-501	Artificial Neural Network and Applications	
Teaching scheme:		**Examination scheme:**
Lecture	3 hrs /week	Theory In Semester Evaluation : 20 Marks Mid Semester Examination: 30 Marks End Semester Examination: 50 Marks
Tutorial	--	
Practical	2 hrs/week	
Credit	4	

Course Objectives:	
1.	To understand the fundamental theory and concepts of neural networks.
2.	To provide knowledge of neural network modeling, several neural network paradigms, its applications and recent trends.
3.	To analyze feed forward and feedback neural networks.
4.	To apply auto associative and recurrent neural networks for pattern storage and retrieval
5.	To analyze self-organizing maps
Course Outcomes: On successful completion of this course, students will be able to	
1.	Understanding the basic structures of artificial neural network, their limitations, basic pattern analysis tasks such as classification and clustering, learning and adaptation using the learning rules, implementation of learning rule.
2.	Describe the concepts of feed forward neural networks using single layer and multilayer networks to solve classification problem, and its implementation, single layer feedback networks to study the concept of memory using neural networks.
3.	Analyze and implement the applications of neural networks in character recognition and control systems.
4.	Understand Auto associative neural networks, Pattern storage and retrieval, Hopfield model, recurrent neural networks
5.	Analyze Bayesian neural networks, Radial basis function networks
6.	Understand self-organizing maps and recent trends in neural networks

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	1	1	1	2	-	-	-	-	-	-	-	3	3	2
CO2	3	2	2	3	2	-	-	-	-	-	-	-	3	2	2
CO3	2	3	2	3	2	-	-	-	-	-	-	-	3	3	2
CO4	2	2	3	2	2	-	-	-	-	-	-	-	3	3	2
CO5	3	3	2	3	2	-	-	-	-	-	-	-	3	2	2
CO6	3	2	2	2	2	-	-	-	-	-	--	-	2	3	3
CO (total)	17	15	15	16	14	-	-	-	-	-	-	-	19	18	16
CO(avg)	2	2	2	2	2	-	-	-	-	-	-	-	3	3	3

Syllabus	
Unit 1	Brain Style Computing: Origins and Issues, Biological neural networks, Neuron Abstraction, Neuron Signal Functions, Mathematical Preliminaries, Artificial Neurons, Neural Networks and Architectures Pattern analysis tasks: Classification, Clustering, mathematical models of neurons, Structures of neural networks, Learning principles.
Unit 2	Feed forward neural networks: Pattern classification using perceptron, Multilayer feedforward neural networks (MLFFNNs), Pattern classification and regression using MLFFNNs, Error backpropagation learning.
Unit 3	Fast learning methods: Conjugate gradient method. Autoassociative neural networks, Pattern storage and retrieval, Hopfield model, recurrent neural networks Bayesian neural networks, Radial basis function networks: Regularization theory, RBF networks for function approximation, RBF networks for pattern classification.
Unit 4	Self-organizing maps: Pattern clustering, Topological mapping, Kohonen's selforganizing map.
Unit 5	Recent Trends in neural networks: Introduction to deep neural network, convolutional neural network, RNN, LSTM, etc.
Text/Reference Books:	
1.	Jacek Zurada, Introduction to Artificial Neural Networks, Jaico Publishing House, 1997.
2.	Satish Kumar, Neural Networks, A Classroom Approach, Tata McGraw-Hill, 2003
3.	S.Haykin, Neural Networks, A Comprehensive Foundation, Prentice Hall, 1998.
4.	C.M.Bishop, Pattern Recognition and Machine Learning, Springer, 2006.
5.	Ian Goodfellow and Yoshua Bengio and Aaron Courville , Deep Learning, MIT Press, 2016

List of Equivalent Subjects from SWAYAM/NPTEL for Credit Transfer

Sr. No.	Institute Course		Details of Course from SWAYAM/NPTEL
	Course Code	Title of the Course	Deep Learning - Part 1 By Prof. Sudarshan Iyengar, Prof. Padmavati
1.	PCC-AI-501	Artificial Neural Network and Applications	https://swayam.gov.in/nd1_noc20_cs50/preview

PCC-AI-502	Digital Image and Video Processing	
Teaching scheme:		**Examination scheme:**
Lecture	3 hrs /week	Theory In Semester Evaluation : 20 Marks Mid Semester Examination: 30 Marks End Semester Examination: 50 Marks
Tutorial	--	
Practical	2 hrs/week	
Credit	4	

Course Objectives:	
1.	To understand the fundamentals and mathematical models in digital image and video processing
2.	To apply time and frequency domain techniques for image enhancement
3.	To analyze current technologies and issues in image and video processing
4.	To evaluate and implement image and video processing applications in practice.

Course Outcomes: On successful completion of this course, students will be able to	
1.	Understand theory and models in Image and Video Processing.
2.	Interpret and analyze 2D signals in frequency domain through image transforms.
3.	Apply quantitative models of image and video processing for various engineering applications.
4.	Develop innovative design for practical applications of image and video processing in various fields.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	1	2	-	-	-	-	-	-	-	3	3	2
CO2	3	2	2	3	2	-	-	-	-	-	-	-	3	2	2
CO3	2	3	2	3	2	-	-	-	-	-	-	-	3	3	2
CO4	2	2	3	2	2	-	-	-	-	-	-	-	3	3	2
CO (total)	9	8	8	9	8	-	-	-	-	-	-	-	12	11	8
CO(avg)	2	2	2	2	2	-	-	-	-	-	-	-	3	3	2

Syllabus	
Unit 1	**Image Fundamentals:** Image acquisition, Image Digitization, sampling and quantization, image resolution, basic relationship between pixels, Image Formation Model, Geometrical transformation, Camera Modelling, Stereo vision, , Colour images, RGB, HSI and other models, Different Imaging Modalities.
Unit 2	**Two Dimensional Transforms:** Discrete Fourier Transform, Discrete Cosine Transform, Walsh and Hadamard Transform, Haar Transform, Discrete Wavelet Transform, and its Applications.
Unit 3	**Image Enhancement** Spatial Domain: Point Processing: Digital Negative, contrast stretching, thresholding, gray level slicing, bit plane slicing, log transform and power law transform, Histogram Equalization and Specification, Neighborhood Processing: Averaging filters, order statistics filters, high pass filters and high boost filters, Frequency domain filtering.
Unit 4	**Image Segmentation:** Point, line and edge detection, edge linking using Hough transform and graph theoretic approach, thresholding, and region-based segmentation Clustering Algorithms.
Unit 5	**Morphological Image processing and Texture:** Dilation, erosion, opening, closing, hit or miss transform, thinning and thickening, and boundary extraction on binary images, Texture: statistical Texture description, Methods based on spatial frequencies, Occurrence matrices, Edge Frequency, Law's texture Energy measures
Unit 6	**Video Formation, Perception and Representation** Digital Video Sampling, Video Frame classifications, I, P and B frames, Notation, Digital Video formats, Digital video quality measure, Video Capture and display: Principle of colour video camera, video camera, digital video, Sampling of video Signals: Required sampling rates, sampling in two dimensions and three dimensions, progressive virus interlaced scans, MPEG
Unit 7	**Two-Dimensional Motion Estimation** Optical Flow: 2-D motion Vs optical flow, optical flow equations, motion representation, motion estimation criteria, optimization method, Block Matching Algorithms: Exhaustive block matching algorithms, phase correlation method, Binary feature matching.
Text/Reference Books:	
1.	Gonzales and Woods, "Digital Image Processing", Pearson Education, India, Third Edition.
2.	Anil K.Jain, "Fundamentals of Image Processing", Prentice Hall of India, First Edition, 1989.
3.	Murat Tekalp, "Digital Video Processing", Pearson, 2010.
4.	John W. Woods, "Multidimensional Signal, Image and Video Processing", Academic Press 2012.
5.	J.R.Ohm , "Multimedia Communication Technology", Springer Publication.
6.	A.I.Bovik, "Handbook on Image and Video Processing", Academic Press.

List of Equivalent Subjects from SWAYAM/NPTEL for Credit Transfer

Sr. No.	Institute Course		Details of Course from SWAYAM/NPTEL
	Course Code	Title of the Course	https://nptel.ac.in/courses/117/105/117105079/
1.	PCC-AI-502	Digital Image and Video Processing	

PCC-AI-503	**Statistical Machine Learning**	
Teaching scheme:		**Examination scheme:**
Lecture	3 hrs /week	Theory In Semester Evaluation : 20 Marks Mid Semester Examination: 30 Marks End Semester Examination: 50 Marks
Tutorial	--	
Practical	2 hrs/week	
Credit	4	

Course Objectives:	
1.	To understand statistical methods in Machine Learning.
2.	To apply different supervised learning algorithms.
3.	To apply and implement different unsupervised learning algorithms.
4.	To evaluate different Ensemble techniques.
5.	To understand different evaluation measures and cross validation in Machine Learning
6.	To apply Theory of Generalization.
7.	To analyze Recommendation System

Course Outcomes: On successful completion of this course, students will be able to	
1.	Identify appropriate statistical learning methods for the given problem involving real data.
2.	Identify other possible problems with messy data, such as multicollinearity, understand their consequences, and propose solutions.
3.	Use training and testing data to evaluate performance of the chosen regression and classification techniques and compare them.
4.	Apply cross-validation techniques to find the optimal degree of flexibility -the best subset of predictors or the optimal tuning parameters.
5.	Show, analytically or empirically, the optimal balance between precision within training data and prediction power.
6.	Develop theory of generalization.
7.	Develop recommendation system.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	1	2	-	-	-	-	-	-	-	3	3	2
CO2	3	2	2	3	2	-	-	-	-	-	-	-	3	2	2
CO3	2	3	2	3	2	-	-	-	-	-	-	-	3	3	2
CO4	2	2	3	2	2	-	-	-	-	-	-	-	3	3	2
CO5	3	3	2	3	2	-	-	-	-	-	-	-	3	2	2
CO6	3	2	2	2	2	-	-	-	-	-	--	-	2	3	3
CO7	2	2	3	2	2	-	-	--	-	-	-	-	2	2	3
CO (total)	17	15	15	16	14	-	-	-	-	-	-	-	19	18	16
CO(avg)	2	2	2	2	2	-	-	-	-	-	-	-	3	3	2

Syllabus	
Unit 1	**Basics and Introduction of Machine Learning** Introduction to Machine Learning, Machine learning Cycle, Supervised Vs Unsupervised and Reinforced Learning, Linear Algebra, Tensor, High Dimensional Vector spaces, Review of Probability and Conditional Probability, Descriptive Statistics.
Unit 2	**Supervised learning**: Linear Regression, Multiple Variable Linear Regression, Gradient Descent, Classification -- Logistic Regression, Naive Bayes Classifiers, K-NN Classification, Support Vector Machines, Performance Measures, Cross validation.
Unit 3	**Unsupervised learning**: Clustering (K-means, Hierarchical), Dimensionality reduction-PCA.
Unit 4	**Ensemble learning**: Decision Trees, Bagging, Random Forest, Boosting
Unit 5	**Theory of Generalization**: In-sample and out-of-sample error, Bias and Variance analysis, Overfitting, Regularization, VC inequality, VC analysis,
Unit 6	**Recommendation System**: Introduction to recommendation systems, Popularity based model, Content Based Recommendation System
Text/Reference Books:	
1.	Christopher M. Bishop. Pattern Recognition and Machine Learning (Springer)
2.	David Barber, Bayesian Reasoning and Machine Learning (Cambridge University Press)
3.	Tom Mitchell. Machine Learning (McGraw Hill)
4.	Richard O. Duda, Peter E. Hart, David G. Stork. Pattern Classification (John Wiley & Sons)

List of Equivalent Subjects from SWAYAM/NPTEL for Credit Transfer

Sr. No.	Institute Course		Details of Course from SWAYAM/NPTEL
	Course Code	Title of the Course	
1.	PCC-AI-503	Statistical Machine Learning	https://nptel.ac.in/courses/106/106/106106139/

PEC-AI-504	Advanced Digital Signal Processing	
Teaching scheme:		**Examination scheme:**
Lecture	3 hrs /week	Theory In Semester Evaluation : 20 Marks Mid Semester Examination: 30 Marks End Semester Examination: 50 Marks
Tutorial	--	
Practical	2 hrs/week	
Credit	4	

Course Objectives:	
1.	To design FIR and IIR digital filters and its implementation.
2.	To analyze the fundamentals of multirate DSP systems.
3.	To provide understanding of the QMFs and digital filter banks.
4.	To apply the principles and concepts of linear prediction and power spectrum estimation

Course Outcomes: On successful completion of this course, students will be able to	
1.	To understand theory of different filters and algorithms.
2.	To understand theory of multirate DSP, solve numerical problems and write algorithms.
3.	To understand theory of prediction and solution of normal equations.
4.	To know applications of DSP at block level.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	1	2	-	-	-	-	-	-	-	3	3	2
CO2	3	2	2	3	2	-	-	-	-	-	-	-	3	2	2
CO3	2	3	2	3	2	-	-	-	-	-	-	-	3	3	2
CO4	2	2	3	2	2	-	-	-	-	-	-	-	3	3	2
CO (total)	9	8	8	9	8	-	-	-	-	-	-	-	12	11	8
CO(avg)	2	2	2	2	2	-	-	-	-	-	-	-	3	3	2

Syllabus	
Unit 1	Overview of DSP, characterization in time and frequency, FFT algorithms, digital filter design and structures: basic FIR/IIR filter design and structures, design techniques of linear phase FIR filters, IIR filters by impulse invariance, bilinear transformation, FIR/IIR cascaded lattice structures, and parallel all pass realization of IIR.
Unit 2	Half Band filters, pole-zero placement and filter design, digital resonators, periodic notch filters, FIR differentiators and Hilbert transformer, least square filtering.
Unit 3	Multi rate DSP, decimators and interpolators, sampling rate conversion, multistage decimator and interpolator, poly phase filters, QMF, digital filter banks, applications in subband coding.
Unit 4	Linear prediction and optimum linear filters, stationary random process, forward-backward linear prediction filters, solution of normal equations, AR lattice and ARMA lattice-ladder filters.
Unit 5	Estimation of spectra from finite-duration observations of signals, nonparametric methods for power spectrum estimation, parametric methods for power spectrum estimation, minimum- variance spectral estimation.
Unit 6	Application of DSP and multi rate DSP, application to radar, introduction to wavelets, application to image processing, design of phase shifters, DSP in speech processing and other applications.
Text/Reference Books:	
1.	J.G. Proakis and D.G. Manolakis "Digital signal processing: Principles, Algorithm and Applications", 4th Edition, Prentice Hall, 2007.
2.	N. J. Fliege, "Multirate Digital Signal Processing: Multirate Systems -Filter Banks – Wavelets", 1st Edition, John Wiley and Sons Ltd, 1999.
3.	Bruce W. Suter, "Multirate and Wavelet Signal Processing",1st Edition, Academic Press, 1997.
4.	M. H. Hayes, "Statistical Digital Signal Processing and Modeling", John Wiley and Sons Inc., 2002.
5.	D.G. Manolakis, V. K. Ingle and S. M. Kogon, "Statistical and Adaptive Signal Processing Processing", McGraw Hill, 2000

List of Equivalent Subjects from SWAYAM/NPTEL for Credit Transfer

Sr. No.	Institute Course		Details of Course from SWAYAM/NPTEL
	Course Code	Title of the Course	
1.	PEC-AI-504	Advanced Digital Signal Processing	---

PEC-AI-505	Intelligent Information Retrieval	
Teaching scheme:		**Examination scheme:**
Lecture	3 hrs /week	Theory In Semester Evaluation : 20 Marks Mid Semester Examination: 30 Marks End Semester Examination: 50 Marks
Tutorial	--	
Practical	2 hrs/week	
Credit	4	

Course Objectives:	
1.	To understand the theoretical basis behind the standard models of IR (Boolean, Vector-space, Probabilistic and Logical models),
2.	To understand the difficulty of representing and retrieving documents, images, speech, etc.
3.	To apply run and test a standard IR system.
4.	To understand the standard methods for Web indexing and retrieval.
5.	To understand how techniques from natural language processing, artificial intelligence, human-computer interaction, and visualization integrate with IR, and be familiar with various algorithms and systems.
6.	To analyze summarization.
7.	To apply Cross language information retrieval.

Course Outcomes: On successful completion of this course, students will be able to	
1.	Know information retrieval concepts.
2.	Know text indexing, storage and compressing
3.	Know different retrieval models.
4.	Analyze performance evaluation of retrieval system.
5.	Analyze an information problem and identify appropriate retrieval process.
6.	Evaluate the emerging information retrieval practices in library services and on the Web.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	1	2	-	-	-	-	-	-	-	3	3	2
CO2	3	2	2	3	2	-	-	-	-	-	-	-	3	2	2
CO3	2	3	2	3	2	-	-	-	-	-	-	-	3	3	2
CO4	2	2	3	2	2	-	-	-	-	-	-	-	3	3	2
CO5	2	3	2	3	2	-	-	-	-	-	-	-	3	2	2
CO6	2	2	2	2	2	-	-	-	-	-	--	-	2	3	3
CO (total)	13	13	12	14	12	-	-	-	-	-	-	-	17	16	13
CO(avg)	2	2	2	2	2	-	-	-	-	-	-	-	3	3	2

Syllabus	
Unit 1	**Introduction to Information Retrieval:** The nature of unstructured and semi-structured text. Inverted index and Boolean queries.
Unit 2	**Text Indexing, Storage and Compression:** Text encoding: tokenization, stemming, stop words, phrases, index optimization. Index compression: lexicon compression and postings, lists compression. Gap encoding, gamma codes, Zipf's Law. Index construction. Postings size estimation, merge sort, dynamic indexing, positional indexes, n-gram indexes, real-world issues.
Unit 3	**Retrieval Models:** Boolean, vector space, TFIDF, Okapi, probabilistic, language modeling, latent semantic indexing. Vector space scoring. The cosine measure. Efficiency considerations. Document length normalization. Relevance feedback and query expansion. Rocchio.
Unit 4	**Performance Evaluation:** Evaluating search engines. User happiness, precision, recall, F-measure. Creating test collections: kappa measure, interjudge agreement.
Unit 5	**Text Categorization and Filtering:** Introduction to text classification. Naive Bayes models. Spam filtering. Vector space classification using hyperplanes; centroids; k Nearest Neighbors. Support vector machine classifiers. Kernel functions. Boosting.
Unit 6	**Text Clustering:** Clustering versus classification. Partitioning methods. k-means clustering. Mixture of Gaussians model. Hierarchical agglomerative clustering. Clustering terms using documents.
Unit 7	**Advanced Topics:** Summarization, Topic detection and tracking, Personalization, Question answering, Cross language information retrieval.
Unit 8	**Web Information Retrieval:** Hypertext, web crawling, search engines, ranking, link analysis, PageRank, HITS, XML and Semantic web.
Text/Reference Books:	
1.	Manning, Raghavan and Schutze, Introduction to Information Retrieval, Cambridge University Press.
2.	Baeza-Yates and Ribeiro-Neto, Modern Information Retrieval, Addison-Wesley.
3.	Soumen Charabarti, Mining the Web, Morgan-Kaufmann.
4.	Survey by Ed Greengrass available in the Internet.

List of Equivalent Subjects from SWAYAM/NPTEL for Credit Transfer

Sr. No.	Institute Course		Details of Course from SWAYAM/NPTEL
	Course Code	Title of the Course	
1.	PEC-AI-505	Intelligent Information Retrieval	---

PEC-AI-506	Multimedia System Applications	
Teaching scheme:		**Examination scheme:**
Lecture	3 hrs /week	Theory In Semester Evaluation : 20 Marks Mid Semester Examination: 30 Marks End Semester Examination: 50 Marks
Tutorial	--	
Practical	2 hrs/week	
Credit	4	

Course Objectives:	
1.	Achieve a basic understanding of multimedia systems.
2.	Understanding Multimedia data type.
3.	Understand multimedia information representation and relevant signal processing aspects.
4.	Understanding multimedia networking and communications
5.	Apply multimedia standards especially on the audio, image, and video compression.
6.	Evaluate more advanced or future multimedia systems.
Course Outcomes: On successful completion of this course, students will be able to	
1.	Understand different types of multimedia data and basics of image and video.
2.	Understand colour models of image and video.
3.	Analyze and design different compression algorithms.
4.	Analyze and implement different compression standards for image.
5.	Analyze and implement different compression standards for video.
6.	Understand the transmission of multimedia data over communication networks.
7.	Understand multimedia databases.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	1	2	-	-	-	-	-	-	-	3	3	2
CO2	3	2	2	3	2	-	-	-	-	-	-	-	3	2	2
CO3	2	3	2	3	2	-	-	-	-	-	-	-	3	3	2
CO4	2	2	3	2	2	-	-	-	-	-	-	-	3	3	2
CO5	3	3	2	3	2	-	-	-	-	-	-	-	3	2	2
CO6	3	2	2	2	2	-	-	-	-	-	--	-	2	3	3
CO7	2	2	3	2	2	-	-	--	-	-	-	-	2	2	3
CO (total)	17	15	15	16	14	-	-	-	-	-	-	-	19	18	16
CO(avg)	2	2	2	2	2	-	-	-	-	-	-	-	3	3	2

Syllabus	
Unit 1	**Introduction to Multimedia** What is Multimedia? Multimedia and Hypermedia, World Wide Web, Overview of Mu1timedia Software Tools, Fundamentals concepts of Audio, Image and Video Processing.
Unit 2	**Data and Colour Representations** Graphics Image Data Types, Popular File Formats, Color Science, Color Models in Images, Color Models in Video.
Unit 3	**Multimedia Static Data Compression Methods:** **Lossless Compression Algorithms:** Introduction, Basics of Information Theory, Run-Length Coding, Variable-Length Coding (VLC), Dictionary-Based Coding, Arithmetic Coding, Lossless Image Compression **Lossy Compression Algorithms:** Introduction, Distortion Measures, The Rate-Distortion Theory, Quantization, Transform Coding, Wavelet-Based Coding, Wavelet Packets, Embedded Zerotree of Wavelet Coefficients, Set Partitioning in Hierarchical Trees (SPIHT)
Unit 4	**Multimedia Static Data Compression Standards** The JPEG Standard, The JPEG2000 Standard, The JPEG-LS Standard, Bilevel Image Compression Standards.
Unit 5	**Multimedia Dynamic Data Compression Methods and Standards** Basic Video Compression Techniques: Introduction to Video Compression, Video Compression Based on Motion Compensation, H.261, H.263, MPEG Video Coding I - MPEG-1 and 2: Overview, MPEG-1, MPEG-2.
Unit 6	**Multimedia Communication and Retrieval** **Computer and Multimedia Networks:** Basics of Computer and Multimedia Networks, Multiplexing technologies, LAN and WAN, Access Networks, Common peripheral interfaces. **Content-Based Retrieval in Digital Libraries:** - How Should We Retrieve Images? C-BIRD - A Case Study, Synopsis of Current Image Search Systems.
Text/Reference Books:	
1.	Zi-Niam Li and Mark Drew, Fundamentals of Multimedia, Pearson, 2004.
2.	Khalid Sayood, Data Compression, PHI

List of Equivalent Subjects from SWAYAM/NPTEL for Credit Transfer

Sr. No.	Institute Course		Details of Course from SWAYAM/NPTEL
	Course Code	Title of the Course	
1.	PEC-AI-506	Multimedia System Applications	

PEC-AI-507	Cyber Security	
Teaching scheme:		**Examination scheme:**
Lecture	3 hrs /week	Theory In Semester Evaluation : 20 Marks Mid Semester Examination: 30 Marks End Semester Examination: 50 Marks
Tutorial	--	
Practical	2 hrs/week	
Credit	4	

Course Objectives:	
1.	Understand concepts of Cyber Security
2.	Gain in depth knowledge of the flexible and versatile frameworks on the Security.
3.	To analyze Cyber Attacks and its Impact.
4.	To apply knowledge of Internal Security.
5.	Analyze Web Cyber Security Models.
6.	Gain knowledge of Cryptography and Crypto Currencies.
7.	To evaluate Network Security.
Course Outcomes: On successful completion of this course, students will be able to	
1.	To master fundamentals of secret and public cryptography.
2.	To master understanding external and internal threats to an organization
3.	To be familiar with network security threats and countermeasures
4.	Scaling and deploying Cyber Security
5.	Create Security models for email, data, cloud etc security
6.	Project handling for sectors like e-learning, banking, entertainment, telecom etc
7.	Be employable as Cyber Security Engineer.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	1	2	-	-	-	-	-	-	-	3	3	2
CO2	3	2	2	3	2	-	-	-	-	-	-	-	3	2	2
CO3	2	3	2	3	2	-	-	-	-	-	-	-	3	3	2
CO4	2	2	3	2	2	-	-	-	-	-	-	-	3	3	2
CO5	3	3	2	3	2	-	-	-	-	-	-	-	3	2	2
CO6	3	2	2	2	2	-	-	-	-	-	--	-	2	3	3
CO7	2	2	3	2	2	-	-	--	-	-	-	-	2	2	3
CO (total)	17	15	15	16	14	-	-	-	-	-	-	-	19	18	16
CO(avg)	2	2	2	2	2	-	-	-	-	-	-	-	3	3	2

Syllabus	
Unit 1	**Cyber Security Basics** – Overview, what is Cyber Security? What does it matter to us? Where do we use every day? How does it impact you? Your society? Your Country?
Unit 2	**Cyber Attacks and Impact of Cyber Attacks**: External, Internal, and End Point Cybe Attacks and Exploits Hackers and Hacking System Level Memory/Integer/ Operating syster level attacks, Cyber Security, Protection Methods: NSA Security, Framework Mode Detection, Identification, and Protection Risk Mitigation
Unit 3	**Internal Security:** Enterprise Internal Security, Internal Security Access Control, MFA, and SSO Operating System Level Security, Security Codes: Signatures, Sandboxes, and Patterns Detection & Isolation Security Mechanisms based on Signatures, Security Mechanisms based on Sandboxes, Security Mechanisms based on Legacy and Patterns Detection, Identification and Isolation Security Exploitation Techniques, Hackers and hacking methods, Exploiting Wireless Devices, Multiple Exploitation Mechanisms and impact on Systems.
Unit 4	**Web Cyber Security Models and Challenges**: NSA based Web Cyber Security Model, Frame work, Browser Security Architecture, Browser Security impact and challenges, Web Application Cyber Security Challenges, SQL Injection, attacks on the Web Servers, Web Application Security Design and Implementation – Case Study, Internal Security, Identity Access Control Management (IAM), Single Sign On (SSO), Multi Factor Authentication (MFA), Internal Data Integrity and Data protection, Security & Regulatory Compliance, HIPPA, PCI-DSS, FISMA, SOX, CDI
Unit 5	**Cryptography and Crypto Currencies:** Cryptography Security Methods, Hash Keys and Security protection methods, Data Breach attacks due to internal loopholes, Crypto Currencies and Security impact – Case Study of Bit Coins
Unit 6	**Network Security:** External Security Threats and Challenges, Routers, Switches, and Gateways etc, Data Traffic Irregularities and DDOS Attacks, Network Security Vulnerabilities: Ingress and Egress Traffic Security Management, Firewalls, VPN's, and Other Security Solutions, How do you protect the network? Various data breach types and network security impact assessment. Dynamic Threat Intelligence: Threat Intelligence Prediction, Risk Mitigation, Mobile Devices and Platform Security, Mobile Operating Systems & Security Overview, Android and IOS security challenges, Mobile Threats and Malware challenges
Text/Reference Books:	
1.	Matt Bishop, "Computer Security Art and Science", Pearson/PHI, 2002.
2.	Corey Schou, Steven Hernandez, "Information Assurance Handbook: Effective Computer Security and Risk Management Strategies"

List of Equivalent Subjects from SWAYAM/NPTEL for Credit Transfer

Sr. No.	Institute Course		Details of Course from SWAYAM/NPTEL
	Course Code	Title of the Course	Cyber Security
1.	PEC-AI-507	Cyber Security	https://swayam.gov.in/nd2_cec20_cs15/preview

PEC-AI-508	Speech Processing	
Teaching scheme:		**Examination scheme:**
Lecture	3 hrs /week	Theory In Semester Evaluation : 20 Marks Mid Semester Examination: 30 Marks End Semester Examination: 50 Marks
Tutorial	--	
Practical	2 hrs/week	
Credit	4	

Course Objectives:	
1.	To understand Digitization and Recording of speech signal.
2.	To understand human speech production.
3.	To evaluate modelling of speech production.
4.	To apply time domain methods in speech processing.
5.	To analyze features extraction techniques in speech processing.
6.	To explore speech prosody.
7.	Develop speech-based applications.

Course Outcomes: On successful completion of this course, students will be able to	
1.	Work in speech based biometric system.
2.	Interface computer with speech.
3.	Develop time and frequency domain methods for speech processing.
4.	Work in spoken language acquisition system.
5.	To do speech prosody modeling.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	1	2	-	-	-	-	-	-	-	3	3	2
CO2	3	2	2	3	2	-	-	-	-	-	-	-	3	2	2
CO3	2	3	2	3	2	-	-	-	-	-	-	-	3	3	2
CO4	2	2	3	2	2	-	-	-	-	-	-	-	3	3	2
CO5	3	3	2	3	2	-	-	-	-	-	-	-	3	2	2
CO (total)	12	11	10	11	10	-	-	-	-	-	-	-	15	13	10
CO(avg)	2	2	2	2	2	-	-	-	-	-	-	-	3	3	2

Syllabus	
Unit 1	Introduction to speech processing, Digitization and Recording of speech signal, Review of Digital Signal Processing Concepts
Unit 2	Human Speech production, Acoustic Phonetics and Articulatory Phonetics, Different categories speech sounds and Location of sounds in the acoustic waveform and spectrograms.
Unit 3	Uniform Tube Modeling of Speech Production, Speech Perception.
Unit 4	Time Domain Methods in Speech Processing, Analysis and Synthesis of Pole-Zero Speech Model
Unit 5	Short-Time Fourier Transform, Analysis: - FT view and Filtering view, Synthesis: -Filter bank summation (FBS) Method and OLA Method.
Unit 6	Features Extraction, Extraction of Fundamental frequency
Unit 7	Speech Prosody, Speech Prosody Modeling (Fujisaki Model)
Unit 8	Speech based Applications (TTS, ASR and spoken language acquisition)
Text/Reference Books:	
1.	Lawrence R Rabiner and Ronald W Schafer , Introduction to Digital Speech Processing (Foundations and Trends in Signal Processing).
2.	Sadaoki Furui, Digital Speech Processing: Synthesis, and recognition, Second Edition

List of Equivalent Subjects from SWAYAM/NPTEL for Credit Transfer

Sr. No.	Institute Course		Details of Course from SWAYAM/NPTEL
	Course Code	Title of the Course	Digital Speech Processing (IIT Kharagpur) https://nptel.ac.in/courses/117/105/117105145/
1.	PEC-AI-508	Speech Processing	

PEC-AI-509	Big Data Analytics	
Teaching scheme:		**Examination scheme:**
Lecture	3 hrs /week	Theory In Semester Evaluation : 20 Marks Mid Semester Examination: 30 Marks End Semester Examination: 50 Marks
Tutorial	--	
Practical	2 hrs/week	
Credit	4	

Course Objectives:	
1.	To understand terminologies and the core concepts behind big data problems, applications, systems, and the techniques.
2.	To analyze some of the most common frameworks such as Apache Spark, Hadoop, MapReduce.
3.	To evaluate large scale data storage technologies such as in-memory key/value storage systems, NoSQL distributed databases, Apache Cassandra, HBase.
4.	To understand Big Data Streaming Platforms such as Apache Spark Streaming.
5.	To apply Apache Kafka Streams for big data analysis.

Course Outcomes: On successful completion of this course, students will be able to	
1.	Scaling and deploying multi clustering.
2.	Work with clusters
3.	Create Data Models, data interfaces, advanced architectures etc
4.	Fluency in tools like Spark, Scala, RDD, SparkSQL, Spark Streaming, Spark ML, GraphX, Sqoop, Flume, Pig, Hive, Impala, and Kafka Architecture.
5.	Project handling for sectors like e-learning, banking, entertainment, telecom etc
6.	Employable as Data Architect, data lead, Big Data Developer

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	1	2	-	-	-	-	-	-	-	3	3	2
CO2	3	2	2	3	2	-	-	-	-	-	-	-	3	2	2
CO3	2	3	2	3	2	-	-	-	-	-	-	-	3	3	2
CO4	2	2	3	2	2	-	-	-	-	-	-	-	3	3	2
CO5	3	3	2	3	2	-	-	-	-	-	-	-	3	2	2
CO6	3	2	2	2	2	-	-	-	-	-	--	-	2	3	3
CO (total)	15	13	12	14	12	-	-	-	-	-	-	-	17	16	13
CO(avg)	2	2	2	2	2	-	-	-	-	-	-	-	3	3	2

Syllabus	
Unit 1	Introduction to Big Data: Why Big Data and Where did it come from?, Characteristics of Big Data- Volume, Variety, Velocity, Veracity, Valence, Value, Challenges and applications of Big Data.
Unit 2	Enabling Technologies for Big Data, Introduction to Big Data Stack, Introduction to some Big Data distribution packages
Unit 3	Big Data Platforms, Overview of Apache Spark, HDFS, YARN, Introduction to MapReduce, MapReduce Programming Model with Spark, MapReduce Example: Word Count, Page Rank etc.
Unit 4	Big Data Storage Platforms for Large Scale Data Storage, CAP Theorem, Eventual Consistency, Consistency Trade-Offs, ACID and BASE, Introduction to Zookeeper and Paxos, Introduction to Cassandra, Cassandra Internals, Introduction to HBase, HBase Internals
Unit 5	Big Data Streaming Platforms for Fast Data, Introduction to Big Data Streaming Systems, Big Data Pipelines for Real-Time computing, Introduction to Spark Streaming, Kafka, Streaming Ecosystem
Unit 6	Big Data Applications (Machine Learning), Overview of Big Data Machine Learning, Ma-hout Introduction, Big Data Machine Learning Algorithms in Mahout- kmeans, Naïve Bayes etc.
Unit 6	Big data Machine learning with Spark, Big Data Machine Learning Algorithms in Spark- Introduction to Spark MLlib, Introduction to Deep Learning for Big Data
Unit 8	Introduction to Big Data Applications (Graph Processing), Introduction to Pregel, Introduction to Giraph, Introduction to Spark GraphX
Text/Reference Books:	
1.	Dirk Deroos et al., Hadoop for Dummies, Dreamtech Press, 2014.
2.	Chuck Lam, Hadoop in Action, December, 2010.
3.	Leskovec, Rajaraman, Ullman, Mining of Massive Datasets, Cambridge University Press
4.	I.H. Witten and E. Frank, Data Mining: Practical Machine learning tools and techniques.
5.	Erik Brynjolfsson et al., The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies, W. W. Norton & Company, 2014.

List of Equivalent Subjects from SWAYAM/NPTEL for Credit Transfer

Sr. No.	Institute Course		Details of Course from SWAYAM/NPTEL
	Course Code	Title of the Course	Big Data Computing -IIT Patna https://swayam.gov.in/nd1_noc20_cs92/preview
1.	PEC-AI-509	Big Data Analytics	

PEC-AI-510	Embedded System Design	
Teaching scheme:		**Examination scheme:**
Lecture	3 hrs /week	Theory In Semester Evaluation : 20 Marks Mid Semester Examination: 30 Marks End Semester Examination: 50 Marks
Tutorial	--	
Practical	2 hrs/week	
Credit	4	

Course Objectives:

1.	Understand design and development of an embedded system
2.	Evaluate architecture of ARM/ARM Cortex and embedded programming
3.	Develop and Implement interfacing with external devices and programming
4.	Apply concept of RTOS and its importance in embedded application
5.	Analyze engineering applications using ARM Cortex and RTOS

Course Outcomes: On successful completion of this course, students will be able to

1.	Explain ARM Cortex based microcontroller architecture
2.	Write embedded C programs for ARM Cortex based microcontroller
3.	Identify built-in peripherals and develop programs for activating I/O devices
4.	To understand and use different services provided by RTOS
5.	To create applications using services of RTOS inter-task communication.
6.	Design real world applications using the ARM Cortex and RTOS.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	1	2	-	-	-	-	-	-	-	3	3	2
CO2	3	2	2	3	2	-	-	-	-	-	-	-	3	2	2
CO3	2	3	2	3	2	-	-	-	-	-	-	-	3	3	2
CO4	2	2	3	2	2	-	-	-	-	-	-	-	3	3	2
CO5	3	3	2	3	2	-	-	-	-	-	-	-	3	2	2
CO6	3	2	2	2	2	-	-	-	-	-	--	-	2	3	3
CO (total)	15	13	12	14	12	-	-	-	-	-	-	-	17	16	13
CO(avg)	2	2	2	2	2	-	-	-	-	-	-	-	3	3	2

Syllabus	
Unit 1	**Introduction to Embedded System:** Embedded system definition, Examples, Design metrics, Processor Technologies, IC Technologies, Design Technologies, Custom Single Purpose Processor design: Basic architecture, FSM and FSMD with example, GPP-architecture, Classification-GPP, ASIP, DSP, Architecture of Embedded systems, Recent trends in ES.
Unit 2	**Embedded Firmware Design and Development:** Super Loop based Approach, Embedded Operating System based Approach, Embedded Firmware development Languages-Assembly Level based development, High Level Language based Development, Integrated Development Environment, Editor, Assembler, Liker, Loader, Compiler, Cross compiler, Review of Embedded C-Data types, Arithmetic and Logical operations, Brach and Loop operations, Array and Pointers, Character and string, Functions, Pre-processor and Macros, Coding ISRs, Recursive and Re-entrant functions.
Unit 3	**ARM Processor Architecture and Interfacing:** Introduction to ARM/ARM Cortex series, Design philosophy, processors series, versions, features and applications, CMIS standard for ARM Cortex M3/M4 based controllers, LPC1768: Features, architecture, system control, clock & power control, GPIO, Pin connect block, Inter-facing with LED/Seven segment LED and switch
Unit 4	**External Interfacing:** ARM Cortex M3/M4 Microcontroller interfacing: On chip devices like-Timer/Counter, Watchdog Timer, PWM, ADC, DAC, UART, Interfacing of Keypad, Relays and Stepper Motor.
Unit 5	**Basics of Real Time Operating Systems:** Hard Real time and soft Real-time, Differences between General purpose and OS and RTOS, Basic architecture of RTOs, Multitasking, Kernel structure, Task Management system, TCB, Scheduling Algorithms, Inter-process communication, Introduction of MUCOS-II.
Unit 6	**Case study of open source RTOS:** Detail study of any one RTOS like MuCOS-II/Free RTOS etc: Features, kernel structure, Kernel Function, Initialization, Task creation and Management services, Time Management services, Task Scheduling, Inter-process communication (mailbox, queue, events, pipes, etc), porting of Mucos-II poting on ARM7/cortex (M3/M4 architecture).
Unit 7	**Embedded Linux:** Linux for Embedded system, Embedded Linux development system, kernel architecture and configuration, file system, porting on ARM architecture, boot loaders, tool utilities such as Minicomp, Busybox, Redboot, Libc, device drivers-concept, architecture, types, sample character device driver.
Text/Reference Books:	
1.	Sloss, Symes, Wright, ARM System Developers Guide, Elsevier Morgan Kaufman,2005.
2.	Joseph Yiu, Thee Definitive Guide to the ARM Cortex-M3, Elsevier 2010.
3.	Frank Vahid, Embedded System, Wiley India, 2002.
4.	Shibu K. V, Introduction to Embedded System, TMH, 2017.
5.	Rajkamal, Embedded Systems, TMH, 2008.
6.	Prasad: Embedded/Real Time Systems, Wiley-DreamTech India, 2005.
7.	Cortex-M3 series User Manuals and data sheets

List of Equivalent Subjects from SWAYAM/NPTEL for Credit Transfer

Sr. No.	Institute Course		Details of Course from SWAYAM/NPTEL
	Course Code	Title of the Course	
1.	PEC-AI-510	Embedded System Design	

PEC-AI-511	GPU Architecture and Programming	
Teaching scheme:		**Examination scheme:**
Lecture	3 hrs /week	Theory In Semester Evaluation : 20 Marks Mid Semester Examination: 30 Marks End Semester Examination: 50 Marks
Tutorial	--	
Practical	2 hrs/week	
Credit	4	

Course Objectives:	
1.	To understand Computer organization and Architecture
2.	To evaluate GPU architectures.
3.	To analyze Data Parallel Computing.
4.	To understand Scalable parallel Execution.
5.	To explore Memory and data locality.
6.	To apply performance measures in GPU architecture.

Course Outcomes: On successful completion of this course, students will be able to	
1.	Understand GPU architecture.
2.	Create programme for GPU.
3.	Know CUDA C Program Structure.
4.	Gain knowledge of data parallel computing.
5.	Develop pogramming efficiently for Neural Network Training/Inferencing.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	1	2	-	-	-	-	-	-	-	3	3	2
CO2	3	2	2	3	2	-	-	-	-	-	-	-	3	2	2
CO3	2	3	2	3	2	-	-	-	-	-	-	-	3	3	2
CO4	2	2	3	2	2	-	-	-	-	-	-	-	3	3	2
CO5	3	3	2	3	2	-	-	-	-	-	-	-	3	2	2
CO (total)	12	11	10	12	10	-	-	-	-	-	-	-	15	13	10
CO(avg)	2	2	2	2	2	-	-	-	-	-	-	-	3	3	2

Syllabus	
Unit 1	**Computer organization and Architecture:** Review of basic computer organization and architecture, pipelining, structural hazard, data hazard, control hazard. Memory hierarchy, multi-level arrangements, principle of locality, cache mapping, cache blocks, cache write policy. Cache replacement policy, Instruction Level Parallelism (ILP), actual pipeline CPI, Compiler Techniques for ILP, unrolling algorithm, Branch Prediction assisted ILP, hierarchical prediction, Dynamic scheduling for ILP, static scheduling.
Unit 2	**Introduction to GPU architectures:** Handling data level parallelism, Vector processors, introduction to GPUs, Tesla GPU architecture, shader programs, multi-threading in GPUs, first generation GPUs, trade-off between Tesla and GeForce GPUs, graphics in tesla, GPGPU, single instruction multiple thread (SIMT), Warp execution, register file, fermi GTX 480 GPU, fermi streaming microprocessor, fermi memory hierarchy, parallel thread execution (PTX) instruction, GPUs as mobile workload accelerators, NVIDIA driver series of systems.
Unit 3	**Data Parallel Computing:** Data Parallelism, CUDA C Program Structure, A Vector Addition Kernel, Device Global Memory and Data Transfer, Kernel Functions and Threading, Kernel Launch.
Unit 4	**Scalable parallel Execution:** CUDA Thread Organization, Mapping Threads to Multidimensional Data, Image Blur: A More Complex Kernel, Synchronization and Transparent Scalability, Resource Assignment, Querying Device Properties, Thread Scheduling and Latency Tolerance.
Unit 5	**Memory and data locality:** Importance of Memory Access Efficiency, Matrix Multiplication, CUDA Memory Type, Tiling for Reduced Memory Traffic, A Tiled Matrix Multiplication Kernel, Boundary Checks, Memory as a Limiting Factor to Parallelism.
Unit 6	**Performance Considerations :**Global Memory Bandwidth, More on Memory Parallelism, Warps and SIMD Hardware Dynamic Partitioning of Resources, Thread Granularity, Floating-Point Data Representation, Representable Numbers, Special Bit Patterns and Precision in IEEE Format, Arithmetic Accuracy and Rounding, Algorithm Considerations, Linear Solvers and Numerical Stability.
Unit 7	**Application Design :** Efficient Neural Network Training/Inferencing , Application Case Study: MRI, Molecular Visualization and Analysis, Machine learning.
Text/Reference Books:	
1.	David B. Kirk , Wen-mei W. Hwu, " *Programming Massively Parallel Processors: A Hands-on Approach*", Third Edition.
2.	https://www.tutorialspoint.com/cuda/index.htm.
3.	https://cuda-tutorial.readthedocs.io/en/latest/tutorials/tutorial01/

List of Equivalent Subjects from SWAYAM/NPTEL for Credit Transfer

Sr. No.	Institute Course		Details of Course from SWAYAM/NPTEL
	Course Code	Title of the Course	
1.	PEC-AI-511	GPU Architecture and Programming	

PEC-AI-512	Data Structure and Algorithm	
Teaching scheme:		**Examination scheme:**
Lecture	3 hrs /week	Theory In Semester Evaluation : 20 Marks Mid Semester Examination: 30 Marks End Semester Examination: 50 Marks
Tutorial	--	
Practical	2 hrs/week	
Credit	4	

Course Objectives:	
1.	Understand basic analysis techniques.
2.	Evaluate basic design techniques
3.	Analyze induction, recursion, and proof techniques.
4.	Evaluate recurrence equations and how they are used in analysis of algorithms.
5.	Understand advanced data structures: Priority queues, heaps, hash tables, and search trees.
6.	Analyze sorting algorithms and their complexities
7.	Apply basic graph algorithms.

Course Outcomes: On successful completion of this course, students will be able to	
1.	Do worst-case and average-case analysis.
2.	Know induction, recursion, recurrence relations.
3.	Design efficient algorithms.
4.	Learn different sorting algorithms.
5.	Learn design techniques such as greedy-method and dynamic-programming, and graph algorithms.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	1	2	-	-	-	-	-	-	-	3	3	2
CO2	3	2	2	3	2	-	-	-	-	-	-	-	3	2	2
CO3	2	3	2	3	2	-	-	-	-	-	-	-	3	3	2
CO4	2	2	3	2	2	-	-	-	-	-	-	-	3	3	2
CO5	3	3	2	3	2	-	-	-	-	-	-	-	3	2	2
CO (total)	12	11	10	12	10	-	-	-	-	-	-	-	15	13	10
CO(avg)	2	2	2	2	2	-	-	-	-	-	-	-	3	3	2

Syllabus	
Unit 1	**Algorithm Analysis:** Methodologies for Analyzing Algorithms, Asymptotic Notation, A Quick Mathematical Review, Case Studies in Algorithm Analysis, Amortization, Experimentation.
Unit 2	**Basic Data Structures:** Stack sand Queues, Vectors, Lists, and Sequences, Trees, Priority Queues and Heaps, Dictionaries and Hash Tables.
Unit 3	**Search Trees and Skip Lists:** Ordered Dictionaries and Binary Search Trees, AVL Trees, Bounded-Depth Search Trees, Splay Trees, Skip Lists
Unit 4	**Sorting, Sets, and Selection:** Merge-Sort, The Set Abstract Data Type, Quick -Sort, A Lower Bound on Comparison-Based Sorting, Buck et-Sort and Radix-Sort, Comparison of Sorting Algorithms.
Unit 5	**Algorithms Design Techniques:** The Greedy Method, Divide-and-Conquer, Dynamic Programming.
Unit 6	**Graph Algorithms:** The Graph Abstract Data Type, Data Structures for Graphs, Graph Traversal, Directed Graphs, Single-Source Shortest Paths, All-Pairs Shortest Paths, Minimum Spanning Trees
Text/Reference Books:	
1.	Michael Goodrich and Roberto Tamassia, Algorithm Design: Foundations, Analysis, and Internet Examples, Wiley, 2002. ISBN: 0-471-38365-1
2.	S. Sahni, Data Structures, Algorithms, and Applications in C++, Silicon Press, 2/e, 2005.
3.	T. H. Cormen, C. E. Leiserson, R. L. Rivest, and C. Stein, Introduction to Algorithms, MIT Press, 3/e, 2009
4.	A. M. Tenenbaum, Y. Langsam, and M. J. Augenstein, Data Structures Using C and C++, Prentice Hall, 2/e, 1995.

List of Equivalent Subjects from SWAYAM/NPTEL for Credit Transfer

Sr. No.	Institute Course		Details of Course from SWAYAM/NPTEL
	Course Code	Title of the Course	Data Structure and Algorithm (IIT Delhi)
1.	PEC-AI-512	Data Structure and Algorithm	https://nptel.ac.in/courses/106/102/106102064/#

MCC-590	Research Methodology and IPR	
Teaching scheme:		**Examination scheme:**
Lecture	2 hrs /week	Respective Course coordinator will inform evaluation scheme at the beginning of the course.
Tutorial	--	
Practical	0 hrs/week	
Credit	2	

Course Objectives:	
1.	To explain formulation and analysis of research problem.
2.	To describe research ethics and technical writing.
3.	To understand IPR and patent rights.
4.	To demonstrate new developments in IPR with the help of case studies.
Course Outcomes: On successful completion of this course, students will be able to	
1.	Understand research problem formulation.
2.	Analyze research related information and follow research ethics.
3.	Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
4.	Understanding that when IPR would take such important place in growth of individuals and nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general and engineering.
5.	Understand that IPR protection provides an incentive to inventors for further research work and investment in R and D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	1	2	-	-	-	-	-	-	-	3	3	2
CO2	3	2	2	3	2	-	-	-	-	-	-	-	3	2	2
CO3	2	3	2	3	2	-	-	-	-	-	-	-	3	3	2
CO4	2	2	3	2	2	-	-	-	-	-	-	-	3	3	2
CO5	3	3	2	3	2	-	-	-	-	-	-	-	3	2	2
CO (total)	12	11	10	12	10	-	-	-	-	-	-	-	15	13	10
CO(avg)	2	2	2	2	2	-	-	-	-	-	-	-	3	3	2

Syllabus	
Unit 1	Meaning of research problem, sources of research problem, criteria characteristics of a good research problem, errors in selecting a research problem, scope and objectives of research problem. approaches of investigation of solutions for research problem, data collection, analysis, interpretation, necessary instrumentations.
Unit 2	Effective literature studies approaches, analysis plagiarism, research ethics.
Unit 3	Effective technical writing, how to write report, paper developing a research proposal, format of research proposal, a presentation and assessment by a review committee.
Unit 4	Nature of intellectual property: Patents, designs, trade and copyright. process of patenting and development: technological research, innovation, patenting, development. international scenario: international cooperation on intellectual property. procedure for grants of patents, patenting under PCT.
Unit 5	Patent rights: Scope of patent rights. licensing and transfer of technology. patent information and databases. geographical indications.
Unit 6	New developments in IPR: administration of patent system. new developments in IPR; IPR of biological systems, computer software etc. traditional knowledge case studies, IPR and IITs.
Text/Reference Books:	
1.	Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science and engineering students".
2.	Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction".
3.	Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners".
4.	Halbert, "Resisting Intellectual Property", Taylor and Francis Ltd ,2007.
5.	Mayall, "Industrial Design", McGraw Hill, 1992.
6.	Niebel, "Product Design", McGraw Hill, 1974.
7.	Asimov, "Introduction to Design", Prentice Hall, 1962.
8.	Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age", 2016.
9.	T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008.

List of Equivalent Subjects from SWAYAM/NPTEL for Credit Transfer

Sr. No.	Institute Course		Details of Course from SWAYAM/NPTEL
	Course Code	Title of the Course	
1.	MCC-590	Research Methodology and IPR	---

MAC-591	English for Research Paper Writing	
Teaching scheme:		**Examination scheme:**
Lecture	2 hrs /week	Respective Course coordinator will inform evaluation scheme at the beginning of the course.
Tutorial	--	
Practical	0 hrs/week	
Credit		

Course Objectives:	
1.	To understand that how to improve your writing skills and level of readability.
2.	To learn about what to write in each section.
3.	To understand the skills needed when writing a title.
4.	To ensure the good quality of paper at very first-time submission.
Course Outcomes: On successful completion of this course, students will be able to	
1.	Understand how to plan and prepare concise writings by using appropriate words and structured paragraphs.
2.	Explain how to write different sections such as abstracts, introduction, survey, methodology, results, conclusions, etc. in paper and reports.
3.	Describe key skills needed for writing title of a paper or report

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	1	2	-	-	-	-	-	-	-	3	3	2
CO2	3	2	2	3	2	-	-	-	-	-	-	-	3	2	2
CO3	2	3	2	3	2	-	-	-	-	-	-	-	3	3	2
CO (total)	07	06	05	07	06	-	-	-	-	-	-	-	09	08	06
CO(avg)	2	2	2	2	2	-	-	-	-	-	-	-	3	3	2

Syllabus	
Unit 1	Planning and preparation, word order, breaking up long sentences, structuring paragraphs and sentences, being concise and removing redundancy, avoiding ambiguity and vagueness.
Unit 2	Clarifying who did what, highlighting your findings, hedging and criticizing, paraphrasing and plagiarism, sections of a paper, abstracts. Introduction.
Unit 3	Review of the literature, methods, results, discussion, conclusions, the final check.
Unit 4	Key skills are needed when writing a title, key skills are needed when writing an abstract, key skills are needed when writing an introduction, skills needed when writing a review of the literature.
Unit 5	Skills are needed when writing the methods, skills needed when writing the results, skills are needed when writing the discussion, skills are needed when writing the conclusions.
Unit 6	Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission.
Text/Reference Books:	
1.	Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books).
2.	Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3.	Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book.
4.	Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011.

List of Equivalent Subjects from SWAYAM/NPTEL for Credit Transfer

Sr. No.	Institute Course		Details of Course from SWAYAM/NPTEL
	Course Code	Title of the Course	
1.	MAC-591	English for Research Paper Writing	---

PCC-AI-513	Deep Learning	
Teaching scheme:		**Examination scheme:**
Lecture	3 hrs /week	Theory In Semester Evaluation : 20 Marks Mid Semester Examination: 30 Marks End Semester Examination: 50 Marks
Tutorial	--	
Practical	2 hrs/week	
Credit	4	

Course Objectives:	
1.	To understand basic concepts in Convolutional Neural Network (CNN) and deep learning
2.	To evaluate various practical aspects in training deep neural networks
3.	To apply knowledge of regularization techniques for effective training
4.	To understand field of image classification, object detection and semantic segmentation with CNN
5.	Analyzing and applying deep learning algorithms in practical problems

Course Outcomes: On successful completion of this course, students will be able to	
1.	Understand the fundamentals of CNN and deep learning.
2.	Explore techniques in deep learning and the main research in this field.
3.	Create and implement deep neural network systems.
4.	Implement CNN for image classification, detection and Segmentation
5.	Identify new application requirements in the field of computer vision.
6.	Estimate the resources required to achieve the objectives with Deep learning

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	1	2	-	-	-	-	-	-	-	3	3	2
CO2	3	2	2	3	2	-	-	-	-	-	-	-	3	2	2
CO3	2	3	2	3	2	-	-	-	-	-	-	-	3	3	2
CO4	2	2	3	2	2	-	-	-	-	-	-	-	3	3	2
CO5	3	3	2	3	2	-	-	-	-	-	-	-	3	2	2
CO6	3	2	2	2	2	-	-	-	-	-	--	-	2	3	3
CO (total)	15	13	12	14	12	-	-	-	-	-	-	-	17	16	13
CO(avg)	2	2	2	2	2	-	-	-	-	-	-	-	3	3	2

Syllabus	
Unit 1	**Introduction to Convolutional Neural Network (CNN)** Review of ANN, History of Deep Learning, Convolution layer, Activation function, Pooling Layer, Dense Layer, Data processing, Transfer learning, Understanding software and hardware requirement for deep learning, CPU vs. GPU.
Unit 2	**Training Deep CNN architectures** Feedforward Neural Networks, Backpropagation, Loss functions, Study of optimizers, Weight initialization methods, Mini batch gradient descent, Train/Val/Test dataset distributions, Performance matrix, Introduction to programming frameworks like Keras, Theano, TensorFlow and PyTorch.
Unit 3	**Hyperparameter tuning and Regularization** Introduction to various hyper parameters in CNN, Importance of hyper parameter tuning, Bias Variance trade-off, Problem of overfitting, Dropout regularization, L2 regularization, Batch normalization, Early stopping, Dataset augmentation.
Unit 4	**Image Classification with CNN** Simple CNN Example, Understanding 1x1 convolution, Concept of depth wise separable convolution, Vanishing and Exploding Gradients, Skip connections in CNN, Study of various CNN architectures for image classification: LeNet, AlexNet, VGGNet, GoogLeNet, ResNet, MobileNet etc.
Unit 5	**Object Detection and Recognition with CNN** Introduction to object detection and recognition, Convolutional Implementation of sliding windows, understanding region proposals anchor boxes, Bounding box predictions, Non-max suppression, Region based convolutional neural network for object detection, Face recognition case study.
Unit 6	**Semantic Segmentation with CNN** Understanding image segmentation and semantic segmentation, Encoder-decoder architectures, Upsampling, Transpose convolution, Fully convolutional neural networks, Instance segmentation, Applications of semantic segmentation
Unit 7	**Advancement in Deep Learning** Visualizing and understanding convolutional neural network, Introduction to various other applications and era of dep learning like Recurrent Neural Networks (RNN), Generative Adversarial Networks (GAN), Reinforcement learning etc.
Text/Reference Books:	
1.	Ian Goodfellow, Yoshua Bengio and Aaron Courville, "Deep Learning", An MIT Press book, 2016
2.	Charu C. Aggarwal, "Neural Networks and Deep Learning", Springer, 2018
3.	François Chollet, "Deep Learning with Python", Manning Publications, 1st edition
4.	Adrian Rosebrock, "Deep Learning for Computer Vision", Pyimagesearch, 3rd edition
5.	Shantanu Pattanyak "Pro Deep Learning with tensorflow" (2017).
6.	http://cs231n.github.io/neural-networks-1/
7.	http://cs231n.github.io/neural-networks-2/
8.	http://cs231n.github.io/neural-networks-3/

List of Equivalent Subjects from SWAYAM/NPTEL for Credit Transfer

Sr. No.	Institute Course		Details of Course from SWAYAM/NPTEL
	Course Code	Title of the Course	
1.	PCC-AI-513	Deep Learning	---

PCC-AI-514	Natural Language Processing	
Teaching scheme:		**Examination scheme:**
Lecture	3 hrs /week	Theory In Semester Evaluation : 20 Marks Mid Semester Examination: 30 Marks End Semester Examination: 50 Marks
Tutorial	--	
Practical	2 hrs/week	
Credit	4	

Course Objectives:	
1.	To understand the need natural language processing (NLP) and their representation.
2.	To understand the Mathematical foundation, Linguistic essentials for NLP.
3.	To apply the syntax analysis and parsing that is essential for NLP.
4.	To analyze knowledge about the application of NLP.
5.	To evaluate basic programming tools for NLP.
6.	To understand basic NLP problems, tasks and method

Course Outcomes: On successful completion of this course, students will be able to	
1.	Identify different linguistic components of natural language.
2.	Design the various methodologies for supervised, unsupervised and dictionary-based disambiguation.
3.	Design new tagset and a tagger for a given natural language.
4.	Design applications and techniques involving natural language like clustering, information retrieval etc.
5.	Define an NLP problem and find a suitable solution to it.
6.	Demonstrate own program solution

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	1	2	-	-	-	-	-	-	-	3	3	2
CO2	3	2	2	3	2	-	-	-	-	-	-	-	3	2	2
CO3	2	3	2	3	2	-	-	-	-	-	-	-	3	3	2
CO4	2	2	3	2	2	-	-	-	-	-	-	-	3	3	2
CO5	3	3	2	3	2	-	-	-	-	-	-	-	3	2	2
CO6	3	2	2	2	2	-	-	-	-	-	--	-	2	3	3
CO (total)	15	13	12	14	12	-	-	-	-	-	-	-	17	16	13
CO(avg)	2	2	2	2	2	-	-	-	-	-	-	-	3	3	2

Syllabus	
Unit 1	**Introduction to Natural Language Processing (NLP)**: NLP, Task of NLP, Traditional approach to NLP, Deep learning approach to NLP, Introduction to technical tools. Mathematical foundation, Linguistic essentials, Corpus based work.
Unit 2	**Words:** Collocations: Frequency, Mean and variance, Hypothesis testing, Mutual Information Statistical Inference: n-gram models, building n-gram models, Maximum likelihood estimation (MLE), Held out estimation, Deleted estimation, Good turing estimation.
Unit 3	**Word Sense Disambiguation:** Methodological Preliminaries: Supervised and unsupervised learning, Pseudowords, Upper and lower bounds on performance. Supervised Disambiguation: Bayesian classification, An information- theoretic approach. Dictionary based Disambiguation, Unsupervised Disambiguation.
Unit 4	**Grammar:** Markov Models: Hidden Markov Models, HMM implementation, properties and variants. Part-of-speech tagging: Markov Model Taggers, Hidden Markov Model Taggers. Transformation based learning of tags. Other methods and languages. Tagging accuracy and uses of taggers.
Unit 5	**Deep Learning for NLP:** Introduction to deep learning for NLP, Basic perceptron model, Keras basic, Text generation with LSTM with keras and python, Overview of chat boat, Creating chat boat with python**.**
Unit 6	**Application of NLP:** Introduction to information retrieval, Vector Space Model, Term Distribution Models, Latent Semantic Indexing, Machine Translation: Language similarities and differences.
Text/Reference Books:	
1.	C. D. Manning and H. Schutze, "Foundation of Statistical Natural Language Processing", The MIT Press
2.	Daniel Jurafsky & James H. Martin, "Speech and Language Processing", Pearson Education (Singapore) Pte. Ltd.
3.	James Allen, "Natural Language Understanding", Pearson Education
4.	Steven Bird, Ewan Klein, and Edward Loper, "Natural Language Processing with Python, Shroff, 2009

List of Equivalent Subjects from SWAYAM/NPTEL for Credit Transfer

Sr. No.	Institute Course		Details of Course from SWAYAM/NPTEL
	Course Code	Title of the Course	
1.	PCC-AI-514	Natural Language Processing	https://swayam.gov.in/nd1_noc19_cs56/preview

PCC-AI-515	Intelligent System	
Teaching scheme:		**Examination scheme:**
Lecture	3 hrs /week	Theory In Semester Evaluation : 20 Marks Mid Semester Examination: 30 Marks End Semester Examination: 50 Marks
Tutorial	--	
Practical	2 hrs/week	
Credit	4	

Course Objectives:	
1.	Understand the field of Artificial Intelligence (AI) with emphasis on its use to solve real world problems for which solutions are difficult to express using the traditional algorithmic approach.
2.	To evaluate the essential theory behind methodologies for developing systems that demonstrate intelligent behavior including dealing with uncertainty, learning from experience, and following problem solving strategies found in nature.
3.	Analyze intelligent systems
4.	Apply AI in industry, defense, healthcare, agriculture and many other areas.
5.	This course will give the students a rigorous, advanced and professional post-graduate-level foundation in Artificial Intelligence.
Course Outcomes: On successful completion of this course, students will be able to	
1.	Solve AI problems through programming with Python
2.	Learning optimization and inference algorithms for model learning
3.	Design and develop programs for an agent to learn and act in a structured environment.
4.	Build intelligent agents for search and games.
5.	Demonstrate knowledge of the fundamental principles of intelligent systems and would be able to analyse and compare the relative merits of a variety of AI problem solving techniques.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	1	2	-	-	-	-	-	-	-	3	3	2
CO2	3	2	2	3	2	-	-	-	-	-	-	-	3	2	2
CO3	2	3	2	3	2	-	-	-	-	-	-	-	3	3	2
CO4	2	2	3	2	2	-	-	-	-	-	-	-	3	3	2
CO5	3	3	2	3	2	-	-	-	-	-	-	-	3	2	2
CO (total)	12	11	10	12	10	-	-	-	-	-	-	-	15	13	10
CO(avg)	2	2	2	2	2	-	-	-	-	-	-	-	3	3	2

Syllabus	
Unit 1	**Introduction:** what is AI? Foundations of Artificial Intelligence, History of AI, The-State-of-the-art, Risks and Benefits of AI,
Unit 2	**Intelligent Agents: A**gents and Environments, Good behavior: the concept of rationality, The Nature of Environments, The Structure of Agents.
Unit 3	**Problem Solving:** Problem-Solving Agents, Search Algorithms, Uninformed Search Strategies, Informed (Heuristic) Search Strategies, Heuristic Functions, Local Search and Optimization Problems, Local Search in Continuous Spaces, Search with Nondeterministic Actions, Game Theory, Optimal Decisions in Games, Heuristic Alpha--Beta Tree Search.
Unit 4	**Knowledge and Reasoning:** Knowledge-Based Agents, The Wumpus World, Logic, Propositional Logic, Agents Based on Propositional Logic, Syntax and Semantics of First-Order Logic, Knowledge Engineering in First-Order Logic, Unification and First-Order Inference, Forward Chaining, Backward Chaining, Ontological Engineering, Categories and Objects, Events, Mental Objects and Modal Logic, Reasoning Systems for Categories
Unit 5	**Uncertain Knowledge and Reasoning:** Representing Knowledge in an Uncertain Domain, The Semantics of Bayesian Networks, Exact Inference in Bayesian Networks, Approximate Inference for Bayesian Networks, Causal Networks, Time and Uncertainty, Inference in Temporal Models, Hidden Markov Models.
Unit 6	**Multiagent Decision Making:** Properties of Multiagent Environments, Non-Cooperative Game Theory, Cooperative Game Theory, Making Collective Decisions.
Text/Reference Books:	
1.	Russell S. and Norvig P. (2009). Artificial Intelligence: A Modern Approach. Prentice-Hall, 3rd edition.
2.	Luger G.F. and Stubblefield W.A. (2008). Artificial Intelligence: Structures and strategies for Complex Problem Solving. Addison Wesley, 6th edition.

List of Equivalent Subjects from SWAYAM/NPTEL for Credit Transfer

Sr. No.	Institute Course		Details of Course from SWAYAM/NPTEL
	Course Code	Title of the Course	
1.	PCC-AI-515	Intelligent System	https://nptel.ac.in/courses/106/105/106105077/

PEC-AI-516	Data Warehousing and Data Mining	
Teaching scheme:		**Examination scheme:**
Lecture	3 hrs /week	Theory In Semester Evaluation : 20 Marks Mid Semester Examination: 30 Marks End Semester Examination: 50 Marks
Tutorial	-- hrs/week	
Practical	2 hrs/week	
Credit	4	

Course Objectives:

1.	To understand the scope and essentiality of Data Warehousing and Mining.
2.	To analyze data, choose relevant models and algorithms for respective applications.
3.	To evaluate spatial and web data mining.
4.	To develop research interest towards advances in data mining.

Course Outcomes: On successful completion of this course, students will be able to

1.	Understand Data Warehouse fundamentals, Data Mining Principles.
2.	Design data warehouse with dimensional modelling and apply OLAP operations.
3.	Identify appropriate data mining algorithms to solve real world problems.
4.	Compare and evaluate different data mining techniques like classification, prediction, clustering and association rule mining.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	-	2	-	-	2	-	-	2	2	2
CO2	3	2	2	2	2	2	-	-	2	-	-	-	3	3	3
CO3	3	3	1	2	3	2	-	-	2	2	-	2	3	3	2
CO4	3	2	2	2	2	-	2	2	2	2	2	3	2	2	3
CO (total)	12	10	8	8	9	4	4	2	6	6	1	5	10	10	10
CO (avg)	3	3	2	2	3	1	1	1	2	2	-	2	3	3	3

Syllabus

Unit 1	Data Warehouse: Introduction, a Multi-dimensional data model, Data Warehouse Architecture, Data Warehouse Implementation.
Unit 2	Data Mining: Introduction, Data Mining, on what kind of Data, Data Mining Functionalities, Classification of Data Mining Systems, Major issues in Data Mining.
Unit 3	Data Preprocessing: Data cleaning, Data Integration & Transformation, Data Reduction, Discretization & Concept Hierarchy Generation, Data Mining Primitives.
Unit 4	Mining Association roles in large databases: Association rule mining, mining single-dimensional Boolean Association rules from Transactional Databases, Mining Multi-dimensional Association rules from relational databases & Data Warehouses.
Unit 5	Classification & Prediction: Introduction, Classification by Decision tree induction, Bayesian Classification.
Unit 6	Other Classification Methods, Classification by Back propagation, Prediction, Classifier accuracy.
Unit 7	Cluster Analysis: Introduction, Types of data in Cluster analysis, A categorization of major clustering methods, partitioning methods, Hierarchical methods, Density-Based Methods: DBSCAN, Gridbased Method: STING; Model-based Clustering Method: Statistical approach, Outlier analysis.
Text/Reference Books:	
1.	Data Mining Concepts & Techniques, Jiawei Han Micheline Kamber, Morgan Kaufmann Publishers.
2.	Data Warehouse Toolkit, Ralph Kinball, John Wiley Publishers.
3.	Data Mining, Introductory and Advanced Topics, Margaret H.Dunham, Pearson Education.
4.	Data warehousing in the real world, A Practical guide for Building decision support systems, Sam Anahory, Dennis Murray, Pearson Education.

List of Equivalent Subjects from SWAYAM/NPTEL for Credit Transfer

Sr. No.	Institute Course		Details of Course from SWAYAM/NPTEL
	Course Code	Title of the Course	
1.	PEC-AI-516	Data Warehousing and Data Mining	https://nptel.ac.in/courses/106/105/106105174/

PEC-AI-517	Computer Vision	
Teaching scheme:		**Examination scheme:**
Lecture	3 hrs /week	Theory In Semester Evaluation : 20 Marks Mid Semester Examination: 30 Marks End Semester Examination: 50 Marks
Tutorial	--	
Practical	2 hrs/week	
Credit	4	

Course Objectives:	
1.	To understand human vision vs computer vision and relevant aspects.
2.	To evaluate low level Computer Vision
3.	To analyze mid-level Computer Vision
4.	To apply high level Computer Vision
5.	To understand dynamic scene analysis.
6.	To learn 3-D vision system.

Course Outcomes: On successful completion of this course, students will be able to	
1.	Understand different types of Computer Vision systems and basics of image and video.
2.	Understand feature extractions of image and video.
3.	Analyze different computer Vision Systems.
4.	Analyze and implement different motion detection methods for video analysis.
5.	Understand the 2 D- 3D Vision system.
6.	Design Computer Vision System.
7.	Solve real world problems using computer vision.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	1	2	-	-	-	-	-	-	-	3	3	2
CO2	3	2	2	3	2	-	-	-	-	-	-	-	3	2	2
CO3	2	3	2	3	2	-	-	-	-	-	-	-	3	3	2
CO4	2	2	3	2	2	-	-	-	-	-	-	-	3	3	2
CO5	3	3	2	3	2	-	-	-	-	-	-	-	3	2	2
CO6	3	2	2	2	2	-	-	-	-	-	--	-	2	3	3
CO7	2	2	3	2	2	-	-	--	-	-	-	-	2	2	3
CO (total)	17	15	15	16	14	-	-	-	-	-	-	-	19	18	16
CO(avg)	2	2	2	2	2	-	-	-	-	-	-	-	3	3	3

Syllabus	
Unit 1	**Introduction of Computer Vision** Human Vision Vs Computer Vision, Limitations of Human Vision System, Types of Computer Vision, Computer Vision Pipeline, History of Computer Vision, Computer Vision Applications.
Unit 2	**Preprocessing and Low-Level Computer Vision** Image preprocessing, review of linear and non-linear filtering, 2-D Convolution, scale space approach, LoG and DoG, Canny edge detection, edge in multi spectral image, other local preprocessing operators, line, and corner detection.
Unit 3	**Mid-Level Computer Vision: Feature representation and Description** Colour and Texture Features, Shape Feature representation: Region identification, contour-based shape representation and description, region-based shape representation and description, shape classes.
Unit 4	**High-Level Computer Vision: Object Recognition** Knowledge representation, review of statistical object recognition, Bays classifier, KNN classifier, hierarchical and non-hierarchical approach, clustering syntactic object recognition, recognition as a graph matching.
Unit 5	**High-Level Computer Vision: Image Understanding and 3-D Vision** Image understanding, control strategies, top-down and bottom up approach, active contour models –shapes, semantic image segmentation and understanding. Basics of projective geometry, the single view, stereoscopic, and Multiview geometry.
Unit 6	**High-Level Computer Vision: Dynamic Scene Analysis** Estimating motion vectors using sequential search algorithm, logarithmic search algorithm, and hierarchical search, motion analysis, differential motion analysis methods, trajectory detection, optical flow analysis based on correspondence of interest points, Kalman filters.
Text/Reference Books:	
1.	Milan Sonka, V. Hlavac and Roger Boyle, "Image Processing, Analysis and Machine Vision" –Second edition, Thomson Asia Pvt. Ltd., ISBN -981 -240- 061 -3.
2.	Forsyth and Ponce, "Computer Vision: A modern vision" –PHI.
3.	R. Jain, "Computer Vision" –TMH.

List of Equivalent Subjects from SWAYAM/NPTEL for Credit Transfer

Sr. No.	Institute Course		Details of Course from SWAYAM/NPTEL
	Course Code	Title of the Course	
1.	PEC-AI-517	Computer Vision	---

PEC-AI-518	Wavelets and Applications	
Teaching scheme:		**Examination scheme:**
Lecture	3 hrs /week	Theory In Semester Evaluation : 20 Marks Mid Semester Examination: 30 Marks End Semester Examination: 50 Marks
Tutorial	--	
Practical	2 hrs/week	
Credit	4	

Course Objectives:	
1.	To understand the terminology that are used in the wavelet's literature.
2.	To understand the concepts, theory, and algorithms behind wavelets from an interdisciplinary perspective that unifies harmonic analysis (mathematics), filter banks (signal processing), and multiresolution analysis (computer vision).
3.	To analyze the modern signal processing tools using signal spaces, bases, operators, and series expansions.
4.	To apply wavelets, filter banks, and multiresolution techniques to a problem at hand, and justify why wavelets provide the right tool.
5.	To evaluate critically, ask questions, and apply problem-solving techniques
Course Outcomes: On successful completion of this course, students will be able to	
1.	Introduce Transforms in signal processing.
2.	Understand Time -Frequency Analysis and Multi-resolution Analysis.
3.	Study of Wavelets and its Applications

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	1	2	-	-	-	-	-	-	-	3	3	2
CO2	3	2	2	3	2	-	-	-	-	-	-	-	3	2	2
CO3	2	3	2	3	2	-	-	-	-	-	-	-	3	3	2
CO (total)	7	6	5	7	6	-	-	-	-	-	-	-	9	8	6
CO(avg)	2	2	2	2	2	-	-	-	-	-	-	-	3	3	2

Syllabus	
Unit 1	Introduction and fundamentals of linear algebra: the origins of wavelets-are they fundamentally new? other transforms. why wavelets? the concept of scale and resolution, uncertainty, history of wavelet from morlet to daubechies via mallat, different communities and family of wavelets. fundamentals of linear algebra: vector spaces, bases, orthogonality, orthonormality, projection, functions and function spaces, orthogonal functions, orthonormal functions, orthogonal basis functions.
Unit 2	Signal representation in Fourier domain: Fourier series, orthogonality, orthonormality and the method of finding the Fourier coefficients Complex Fourier series, orthogonality of complex exponential bases, Mathematical preliminaries for continuous and discrete Fourier transform, limitations of Fourier domain signal processing.
Unit 3	Discrete wavelet transform and relation to filter banks: Haar scaling functions and function spaces, translation and scaling of $\phi(t)$, orthogonality of translates of $\phi(t)$, function space V_0 , Finer Haar scaling functions, Concepts of nested vector spaces, Haar wavelet function, Scaled and translated Haar wavelet functions, Orthogonality of $\phi(t)$ and $\psi(t)$, Normalization of Haar bases at different scales, Refinement relation with respect to normalized bases, Support of a wavelet system. relation to filter banks: signal decomposition (analysis), relation with filter banks, frequency response, signal reconstruction: synthesis from coarse scale to fine scale, upsampling and filtering, perfect reconstruction filters, QMF conditions, Computing initial s_{j+1} coefficients, concepts of multi-resolution analysis (MRA) and Multi-rate signal processing. perfect reconstruction: alice cancellation and perfect reconstruction with 2-channel filter bank (perfect reconstruction filter banks)
Unit 4	Designing orthogonal wavelet systems and time-frequency analysis -A frequency domain approach: Designing 4-tap and 6-tap Daubechies wavelet coefficients. compact support, regularity, vanishing moments, conjugate quadrature filter banks (CQF). time-frequency analysis: time-frequency - a joint perspective, ideal time frequency behavior, the uncertainty principle the concept of time-bandwidth product, uncertainty bound, evaluating the lower bound on TBP. time frequency plane and its tiling, STFT and WT: STFT and wavelet transform in general, reconstruction and admissibility, discretization of scale.
Unit 5	Variants of the MRA: biorthogonal wavelets, biorthogonality in vector space, biorthogonal wavelet systems, signal representation using biorthogonal wavelet system, design of JPEG 2000 5 by 3 Filter Bank, The wave packet transform, NOBLE Identities and the relation to Haar WPT, M-band Filter Banks.
Unit 6	JTFA Applications: Scalograms, time-frequency distributions: fundamental ideas, an exploration of applications (this will be a joint effort between the instructor and the class): speech, audio, image and video compression; signal estimation / denoising, feature extraction, etc.
Text/Reference Books:	
1.	K. P. Soman, K. I. Rmachandran, N. G. Resmi, “Insight into Wavelets: From Theory to Practice, (Third Edition)”, PHI Learning Pvt. Ltd., 2010.
2.	S. Mallat, "A Wavelet Tour of Signal Processing," 2nd Edition, Academic Press, 1999.
3.	L. Cohen, “Time-frequency analysis”, 1st Edition, Prentice Hall, 1995.
4.	G.Strang and T. Q. Nguyen, “Wavelets and Filter Banks",2nd Edition, Wellesley Cambridge Press, 1998.
5.	I. Daubechies, "Ten Lectures on Wavelets", SIAM, 1992.
6.	P. P. Vaidyanathan, "Multirate Systems and Filter Banks", Prentice Hall, 1993.
7.	M. Vetterli and J. Kovacevic, "Wavelets and Subband Coding", Prentice Hall, 1995.
8.	Rafael C. Gonzalez, Richard E. Woods “Digital Image Processing (Third Edition)”, Pearson International Edition, 2009.
9.	C. S. Burrus, Ramose and A. Gopinath, Introduction to Wavelets and Wavelet Transform, Prentice Hall Inc.

Wavelet Links:	
	http://users.rowan.edu/~polikar/WAVELETS/WTtutorial.html
	http://www.wavelet.org/
	http://www.math.hawaii.edu/~dave/Web/Amara's%20Wavelet%20Page.htm
Additional Reading:	
1.	Barbara Burke Hubbard, "The World according to Wavelets - A Story of a Mathematical Technique in the making", Second Edition, Universities Press (Private) India Limited 2003, Mathematics, Copyright 1998, ISBN 81-7371-450-9, Published by Universities Press (India) Private Limited, 3-5-819, Hyderguda, Hyderabad 500 029 (AP), India.
2.	Stephen Welstead, Fractal and Wavelet Image Compression Techniques, Prentice Hall of India, New Delhi "Eastern Economy Edition, ISBN 81-203-2827-2, c 1999 by Society of Photo-Optical Instrumentation Engineers (SPIE).
3.	George Bachman, Lawrence Narici, Edward Beckenstein, Fourier and Wavelet Analysis, Springer International Edition (SIE), c 2000, Indian Edition, ISBN 81-8128-276-0.

List of Equivalent Subjects from SWAYAM/NPTEL for Credit Transfer

Sr. No.	Institute Course		Details of Course from SWAYAM/NPTEL
	Course Code	Title of the Course	Prof V M Gadre (IIT Bombay)
1.	PEC-AI-518	Wavelets and Applications	http://www.nptelvideos.in/2012/12/advanced-digital-signal-processing.html

PEC-AI-519	Quantum Computing	
Teaching scheme:		**Examination scheme:**
Lecture	3 hrs /week	Theory In Semester Evaluation : 20 Marks Mid Semester Examination: 30 Marks End Semester Examination: 50 Marks
Tutorial	--	
Practical	2 hrs/week	
Credit	4	

Course Objectives:	
1.	Understand necessary knowledge in quantum computing to the learner.
2.	To apply knowledge of Architecture of a Quantum Computing platform.
3.	To impart knowledge of Programming model for a Quantum Computing Program
4.	To evaluate various quantum algorithms.
5.	To apply quantum computing in industries.
Course Outcomes: On successful completion of this course, students will be able to	
1.	Explain the working of a Quantum Computing program, its architecture and program model.
2.	Develop quantum logic gate circuits.
3.	Develop quantum algorithm
4.	Program quantum algorithm on major toolkits.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	1	2	-	-	-	-	-	-	-	3	3	2
CO2	3	2	2	3	2	-	-	-	-	-	-	-	3	2	2
CO3	2	3	2	3	2	-	-	-	-	-	-	-	3	3	2
CO4	2	2	3	2	2	-	-	-	-	-	-	-	3	3	2
CO (total)	9	8	8	9	8	-	-	-	-	-	-	-	12	11	8
CO(avg)	2	2	2	2	2	-	-	-	-	-	-	-	3	3	2

Syllabus	
Unit 1	**Introduction to Quantum Computing**: Motivation, Major players in the industry, Origin of Quantum Computing, Overview of major concepts in Quantum Computing- Qubits and multi-qubits states, Bra-ket notation, Bloch Sphere representation, Quantum Superposition, Quantum Entanglement.
Unit 2	**Math Foundation for Quantum Computing:** Matrix Algebra: basis vectors and orthogonality, inner product and Hilbert spaces, matrices and tensors, unitary operators and projectors, Dirac notation, Eigen values and Eigen vectors.
Unit 3	**Building Blocks for Quantum Program:** Architecture of a Quantum Computing platform, Details of q-bit system of information representation-Block Sphere, Multi-qubits States, Quantum superposition of qubits (valid and invalid superposition), Quantum Entanglement, Useful states from quantum algorithmic perceptive e.g. Bell State, Operation on qubits: Measuring and transforming using gates, Quantum Logic gates and Circuit: Pauli, Hadamard, phase shift, controlled gates, Ising, Deutsch, swap etc; Programming model for a Quantum Computing Program- Steps performed on classical computer, Steps performed on Quantum Computer, Moving data between bits and qubits
Unit 4	**Quantum Algorithms:** Basic techniques exploited by quantum algorithms- Amplitude amplification, Quantum Fourier Transform, Phase Kick-back, Quantum Phase estimation, Quantum Walks; Major Algorithms- Shor's Algorithm, Grover's Algorithm, Deutsch's Algorithm, Deutsch -Jozsa Algorithm; OSS Toolkits for implementing Quantum program- IBM quantum experience, Microsoft Q, Rigetti PyQuil (QPU/QVM)
Text/Reference Books:	
1.	Michael A. Nielsen, "Quantum Computation and Quantum Information", Cambridge University Press.
2.	David McMahon, "Quantum Computing Explained", Wiley
3.	IBM Experience: https://quantumexperience,ng,bluemix.net
4.	Microsoft Quantum Development Kithttps://www.microsoft.com/en-us/quantum/development-kit
5.	Forest SDK PyQuil: https://pyquil.readthedocs.io/en/stable/

List of Equivalent Subjects from SWAYAM/NPTEL for Credit Transfer

Sr. No.	Institute Course		Details of Course from SWAYAM/NPTEL
	Course Code	Title of the Course	
1.	PEC-AI-519	Quantum Computing	

PEC-AI-520	IoT and Applications	
Teaching scheme:		**Examination scheme:**
Lecture	3 hrs /week	Theory In Semester Evaluation : 20 Marks Mid Semester Examination: 30 Marks End Semester Examination: 50 Marks
Tutorial	-- hrs/week	
Practical	2 hrs/week	
Credit	4	

Course Objectives:

1.	To understand the architectural overview of IoT
2.	To exposure various sensors, actuators, and embedded platforms
3.	To analyze various Internet protocols for IoT
4.	To impart knowledge of different cloud platform services
5.	To evaluate real world IoT Applications and design constraints

Course Outcomes: On successful completion of this course, students will be able to

1.	Recognize various devices, sensors and IoT applications
2.	Apply design concept to IoT Solutions and IoT architectures
3.	Analyze basic protocols in wireless sensor network
4.	Design IoT applications in different domain and able to analyse their performance
5.	Design and implementation of IoT solutions using embedded boards, sensors, actuators

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	-	2	-	-	2	-	-	2	2	2
CO2	3	2	2	2	2	2	-	-	2	-	-	-	3	3	3
CO3	3	3	1	2	3	2	-	-	2	2	-	2	3	3	2
CO4	3	2	2	2	2	-	2	2	2	2	2	3	2	2	3
CO5	3	3	2	2	2	-	-	-	-	-	-	-	3	3	2
CO (total)	15	13	10	10	10	4	4	2	6	6	2	5	13	13	12
CO (avg)	3	3	2	2	3	1	1	1	2	2	-	2	3	3	3

Syllabus	
Unit 1	**Introduction to IoT:** Introduction, Definition and characteristics of IoT, IoT Architecture, Physical and Logical Design of IoT, Enabling Technologies in IoT, History of IoT, About Things in IoT, The identification of Iot, About the Internet in IoT, IoT framework
Unit 2	**M2M to IoT:** Machine to Machine, Difference between IoT and M2M, Software defined Networks
Unit 3	**Internet Communication:** TCP/IP protocol suit, IP addresses, Static IP address assignment, MAC addresses, TCP/UDP ports, Application Layer protocol: HTTP
Unit 4	**Sensor Networks:** Definition, Types of sensors, Sensor characteristics, Types of actuators, Examples and working, RFID principles and components, Wireless Sensor networks: History and context, The node, connecting node, Networking nodes, WSN and IoT
Unit 5	**Communication Protocols:** WPAN Technologies for IoT: IEEE 802.15.4, Zigbee, 6Low PAN, Wireless HART, NFC, Z-Wave, BLE, Bacnet, Modbus CAN, I2C, USB
Unit 6	**IP based Protocols for IoT**: IPV6, RPL, REST, MQTT, SMQTT, CoAP, AMQP
Unit 7	**Interoperability in IoT:** Introduction to Arduino Programming, Integration of Sensors and Actuators with Arduino, Introduction to Python programming, Introduction to Raspberry pi board, Implementation of IoT with Raspberry Pi/Beagle Black board.
Unit 8	**Introduction to SDN**: SDN for IoT, Data Handling and Analytics, Cloud Computing, Sensor-Cloud, Fog computing, Fog Computing
Text/Reference Books:	
1.	Vijay Madisetti, Arshdeep Bahga, "Internet of Things: A Handbook-on Approach, VPT, 2014
2.	Waltenegus Dargie, Chistain Poellabauer: Fundamnetals of Wireless Sensor Network: Theory and Practice
3.	Francis daCosta, Rethinking the Internet of Things: A Scalable Approach to Connecting Everything, Apress Pub, 2013

List of Equivalent Subjects from SWAYAM/NPTEL for Credit Transfer

Sr. No.	Institute Course		Details of Course from SWAYAM/NPTEL
	Course Code	Title of the Course	
1.	PEC-AI-520	IoT and Applications	

PCC-AI-521	Soft Computing and Applications	
Teaching scheme:		**Examination scheme:**
Lecture	3 hrs /week	Theory In Semester Evaluation : 20 Marks Mid Semester Examination: 30 Marks End Semester Examination: 50 Marks
Tutorial	--	
Practical	2 hrs/week	
Credit	4	

Course Objectives:	
1.	Understand soft computing concepts and techniques and develop abilities in designing and implementing soft computing based .
2.	Apply fuzzy systems and fuzzy logic for problem solving.
3.	Introduce students to genetic algorithm and its applications.
4.	Evalaute the possible hybridization of Neural Networks, Fuzzy Logic and Genetic Algorithm

Course Outcomes: On successful completion of this course, students will be able to	
1.	Identify and describe soft computing techniques and their roles in building intelligent machines
2.	Apply fuzzy logic and reasoning to handle uncertainty and solve engineering problems
3.	Apply genetic algorithms to combinatorial optimization problems
4.	Understand soft computing techniques and their role in problem solving.
5.	Analyze and integrate various soft computing techniques to solve problems effectively and efficiently.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	1	2	-	-	-	-	-	-	-	3	3	2
CO2	3	2	2	3	2	-	-	-	-	-	-	-	3	2	2
CO3	2	3	2	3	2	-	-	-	-	-	-	-	3	3	2
CO4	2	2	3	2	2	-	-	-	-	-	-	-	3	3	2
CO5	3	3	2	3	2	-	-	-	-	-	-	-	3	2	2
CO (total)	12	11	10	12	10	-	-	-	-	-	-	-	15	13	10
CO(avg)	2	2	2	2	2	-	-	-	-	-	-	-	3	3	2

Syllabus	
Unit 1	**Soft Computing:** Introduction, requirement, different tools and techniques, usefulness and applications.
Unit 2	**Fuzzy sets and Fuzzy logic:** Introduction, Fuzzy sets versus crisp sets, operations on fuzzy sets, Extension principle, Fuzzy relations and relation equations, Fuzzy numbers, Linguistic variables, Fuzzy logic, Linguistic hedges, Applications, fuzzy controllers, fuzzy pattern recognition, fuzzy image processing, fuzzy database.
Unit 3	**Fuzzy inference and decision-making** natural language, linguistic hedges, rule-based systems, decomposition of compound rules, likelihood and truth quantification, aggregation of fuzzy rules, synthetic evaluation, preferences and consequences, multi-objective decision making.
Unit 4	**Genetic Algorithm:** Solving optimization problems, Concept of GA, GA Operators: Crossover, Mutation.
Unit 5	**Hybrid Systems:** Neural-Network-Based Fuzzy Systems, Fuzzy Logic-Based Neural Networks, Application of soft computing in pattern recognition. New trends in Soft Computing.
Text/Reference Books:	
1.	Klir & Yuan, Fuzzy Sets and Fuzzy Logic, PHI, 1997.
2.	J.-S. R. Jang, C.-T. Sun, E. Mizutani: Neuro- Fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence, PHI, 2005.
3.	An Introduction to Genetic Algorithm Melanic Mitchell -MIT Press,1999
4.	Timothy J Ross: Fuzzy logic with engineering applications, TMH, 2000.
5.	Soft Computing: Fundamentals and Applications by D.K.Pratihar, Narosa Publishing House, New-Delhi, 2014

List of Equivalent Subjects from SWAYAM/NPTEL for Credit Transfer

Sr. No.	Institute Course		Details of Course from SWAYAM/NPTEL
	Course Code	Title of the Course	Introduction To Soft Computing By Prof. Debasis Samanta
1.	PEC-AI-521	Soft Computing and Applications	https://swayam.gov.in/nd1_noc20_cs17/preview

PEC-AI-522	Bio Image Analytics	
Teaching scheme:		**Examination scheme:**
Lecture	3 hrs /week	Theory In Semester Evaluation : 20 Marks Mid Semester Examination: 30 Marks End Semester Examination: 50 Marks
Tutorial	-- hrs/week	
Practical	2 hrs/week	
Credit	4	

Course Objectives:

1.	To understand the importance and acquisition of various medical imaging modalities
2.	To understand medical imaging formats with visualization tools.
3.	To evaluate the significance of various quantitative performance evaluation matrices
4.	To explore field of medical image classification, segmentation and registration with conventional methods and with advanced deep CNN architectures.
5.	To apply above mentioned algorithms on real world patient data

Course Outcomes: On successful completion of this course, students will be able to

1.	Use medical imaging modalities for specified diagnostics
2.	Understand and use various performance evaluation metrics with bioimages
3.	Apply textural statistical feature with different BioImages
4.	Implement CNN architecture for Bio-Image classification, detection.
5.	Design and implement CNN architecture for BioImage segmentation

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	-	2	-	-	2	-	-	2	2	2
CO2	3	2	2	2	2	2	-	-	2	-	-	-	3	3	3
CO3	3	3	1	2	3	2	-	-	2	2	-	2	3	3	2
CO4	3	2	2	2	2	-	2	2	2	2	2	3	2	2	3
CO5	3	2	2	2	2	-	-	-	-	-	-	-	3	2	2
CO (total)	15	12	10	10	11	4	4	2	6	6	2	5	13	12	12
CO (avg)	3	3	2	2	2	2	2	2	2	2	2	2	3	3	2

Syllabus	
Unit 1	Need of imaging in medical domain. Radiographic and Microscopic histopathology images. Introduction to medical imaging modalities like X-Ray, Computed Tomography, Magnetic Resonance Imaging, Ultrasound, Retinal Images, Optical Coherent Tomography, Positron Emission Tomography etc. Advantages and disadvantages of each imaging modality. Image acquisition protocols for CT and MRI. Significance of multimodal MRI data. Staining in histopathology images, Hematoxylin and Eosin stain for comprehensive picture of the microanatomy of organs and tissues
Unit 2	Study of various medical imaging file formats like DICOM, nifty, mha. .mhd, .SVS etc. Study of medical image analysis tools like 3D slicer, ITK-Snap, MIPAV, Radiant, CaPTk etc. Quantitative and qualitative performance evaluation. Understanding various performance evaluation metrics like Sensitivity, Specificity, Accuracy, Precision, Recall, ROC, Dice, Jaccard, Hausdorff distance, Kappa, COX-regression etc. Medical image annotation. Various pre-processing and post processing techniques like z-score normalization, min-max normalization, stain normalization, 3D connected component analysis, Conditional Random Forests
Unit 3	Textures in biomedical images, Models for the Generation of Texture, Statistical Analysis of Texture with the gray level cooccurrence matrix, Haralick's measures of texture, Fourier domain Analysis of Texture, Case Study - Analysis of Breast Masses Using Texture and Gradient Measures.
Unit 4	Need of medical image classification. Review of popular conventional machine learning classifiers like SVM, MPL etc. Study of advanced deep convolutional neural network based classification approaches like AlexNet, VGG, ResNet, Inception, MobileNet etc. Medical image classification case studies: 1. Classification of retinal images with and without pathological myopia 2. Classification of brain tumours into benign or malignant and High Grade or Low Grade 3. Classification of microscopy pathology images into different tumour types. 4. Classification of various skin cancer diseases
Unit 5	Need of medical image segmentation. Conventional segmentation algorithms like K-means, Fuzzy C-means and Gaussian Mixture Models Challenges in medical image segmentation. Study of state-of-the-art segmentation approaches like U-Net, SegNet, FCN, FPN etc. Class imbalance problem for under-represented labels. Abnormality Localization and Segmentation case studies 1. Localisation of Nodules in lung CT images 2. Brain tumor segmentation in multi modal MR images 3. Lung field segmentation 4. Skin lesion Segmentation
Unit 6	Need of Registration in multi-modal medical images like MRI and CT. 1. Registration of multimodal radiographic images for medical image fusion applications. 2. Registration of multiple pathology images for a single specimen which is taken out by biopsy. Registration of histology images to create a 3D reconstruction from scanned 2D thin slices. Generative adversarial networks to address the class imbalance problem in medical images. Unsupervised and semi-supervised learning for weakly annotated medical datasets
Text/Reference Books:	
1.	Biomedical Image Analysis by Rangaraj Rangayan, CRC Press, 2005

2.	Medical Image Processing, Techniques and Applications by Geoff Dougherty, Springer, 2011
3.	Digital Image Processing for Medical Applications by Geoff Dougherty, Cambridge University press, 2009
4.	Squire's fundamentals of radiology, by R. Novelline, Harvard University Press, 2018
5.	https://refuge.grand-challenge.org/
6.	https://www.med.upenn.edu/cbica/brats2020/
7.	https://www.med.upenn.edu/cbica/cpm-rad-path-2019/
8.	https://challenge2020.isic-archive.com/
9.	https://luna16.grand-challenge.org/
10.	https://lndb.grand-challenge.org/
11.	https://anhir.grand-challenge.org/

List of Equivalent Subjects from SWAYAM/NPTEL for Credit Transfer

Sr. No.	Institute Course		Details of Course from SWAYAM/NPTEL
	Course Code	Title of the Course	
1.	PEC-AI-522	Bio Image Analytics	

PEC-AI-523	Foundation of Cognitive Robotics	
Teaching scheme:		**Examination scheme:**
Lecture	3 hrs /week	Theory In Semester Evaluation : 20 Marks Mid Semester Examination: 30 Marks End Semester Examination: 50 Marks
Tutorial	-- hrs/week	
Practical	2 hrs/week	
Credit	4	

Course Objectives:

1.	Understand human sensorimotor and cognitive abilities with a focus on action execution and understanding.
2.	The implementation of sensorimotor and cognitive abilities.
3.	The evaluate assistive technologies to alleviate sensory disabilities and the implementation of robotic rehabilitation devices with a special attention on user requirements and strict clinical assessment.
4.	Apply modelling as a method and know about different types of cognitive models.
5.	Evaluate knowledge and inspiration of biological solutions and implement new technical solutions.

Course Outcomes: On successful completion of this course, students will be able to

1.	Application of Artificial Intelligence, Neural Networks and Reinforcement learning in Robotics.
2.	Design of robotic systems for new applications.
3.	Understand how our psychology and neuroscience understanding of behavior and intelligence informs the design of robotics models and applications.
4.	Compare, select and apply different machine learning methods for intelligent behavior in robots.
5.	Analyze the methods and software/hardware technologies for robotics research and applications.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	-	2	-	-	2	-	-	2	2	2
CO2	3	2	2	2	2	2	-	-	2	-	-	-	3	3	3
CO3	3	3	1	2	3	2	-	-	2	2	-	2	3	3	2
CO4	3	2	2	2	2	-	2	2	2	2	2	3	2	2	3
CO5	3	2	2	2	2	-	-	--	-	-	-	-	3	3	2
CO (total)	15	12	10	10	11	4	4	2	6	6	2	5	13	13	12
CO (avg)	3	3	2	2	3	2	2	2	2	2	-	2	3	3	2

Syllabus	
Unit 1	**Introduction**
Unit 2	**Neural Signaling & Sensory System** Anatomy of human brain, Robot and Human Robot Interaction, Mechanisms of neural excitability and propagation: Classical Model, New Concepts in Axonal Excitation, Functioning of Sensory system.
Unit 3	**Intelligence, Thinking, Artificial Intelligence and Theory of Intelligence** Thinking, Cognition, and Intelligence, Defining Intelligence - Embodiment and Its Implications, Role of Neuroscience and Bio robotics, Synthetic Methodology for Intelligence.
Unit 4	**Intelligent System Design and Cognition Development** Properties of Complete Agents, Agent Design Principle, Developmental Robot Design, Matching brain and Body Dynamics
Unit 5	**Control of Intelligent Systems- AI based Approach** Artificial Neural Networks (ANN), Fuzzy Logic, Genetic Algorithms and Other Nature Inspired Methods, Optimal Control using ANN
Text/Reference Books:	
1.	Neuroscience, edited by Dale Purves, et al., published by Sinauer Associates.
2.	How the body shapes the way we think-A New View of Intelligence, by Rolf Pfeifer and Josh Bongard, MIT Press.
3.	Control Systems: Classical, Modern, and AI-Based Approaches, by Jitendra R. Raol, Ramakalyan Ayyagari, CRC Press.

List of Equivalent Subjects from SWAYAM/NPTEL for Credit Transfer

Sr. No.	Institute Course		Details of Course from SWAYAM/NPTEL
	Course Code	Title of the Course	https://swayam.gov.in/nd1_noc20_me92/preview
1.	PEC-AI-523	Foundation of Cognitive Robotics	https://nptel.ac.in/noc/courses/noc20/SEM2/noc20-me92/

OEC-801	Business Analytics	
Teaching scheme:		**Examination scheme:**
Lecture	3 hrs /week	Theory In Semester Evaluation : 20 Marks Mid Semester Examination: 30 Marks End Semester Examination: 50 Marks
Tutorial	--	
Practical	0 hrs/week	
Credit		

Course Objectives:	
1.	To understand the role of business analytics within an organization.
2.	To analyze data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization.
3.	To gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making
4.	To become familiar with processes needed to develop, report, and analyze business data.
5.	To use decision-making tools/Operations research techniques.
6.	To mange business process using analytical and management tools.
7.	To analyze and solve problems from different industries such as manufacturing, service, retail, software, banking and finance, sports, pharmaceutical, aerospace etc.
Course Outcomes: On successful completion of this course, students will be able to	
1.	Demonstrate knowledge of data analytics.
2.	Demonstrate the ability of think critically in making decisions based on data and deep analytics.
3.	Demonstrate the ability to use technical skills in predicative and prescriptive modeling to support business decision-making.
4.	Demonstrate the ability to translate data into clear, actionable insights.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	1	2	-	-	-	-	-	-	-	3	3	2
CO2	3	2	2	3	2	-	-	-	-	-	-	-	3	2	2
CO3	2	3	2	3	2	-	-	-	-	-	-	-	3	3	2
CO4	2	2	3	2	2	-	-	-	-	-	-	-	3	3	2
CO (total)	9	8	8	9	8	-	-	-	-	-	-	-	12	11	8
CO(avg)	2	2	2	2	2	-	-	-	-	-	-	-	3	3	2

Syllabus	
Unit 1	**Business analytics:** Overview of business analytics, scope of business analytics, business analytics process, relationship of business analytics process and organization, competitive advantages of business analytics. statistical tools: statistical notation, descriptive statistical methods, review of probability distribution and data modeling, sampling and estimation methods overview.
Unit 2	**Trendiness and regression analysis**: Modeling relationships and trends in data, simple linear regression. important resources, business analytics personnel, data and models for business analytics, problem solving, visualizing and exploring data, business analytics technology.
Unit 3	**Organization structures of business analytics;** team management, management issues, designing information policy, outsourcing, ensuring data quality, measuring contribution of business analytics, managing changes. descriptive analytics, predictive analytics, predicative modeling, predictive analytics analysis, data mining, data mining methodologies, prescriptive analytics and its step in the business analytics process, prescriptive modeling, nonlinear optimization.
Unit 4	**Forecasting techniques:** Qualitative and judgmental forecasting, statistical forecasting models, forecasting models for stationary time series, forecasting models for time series with a linear trend, forecasting time series with seasonality, regression forecasting with casual variables, selecting appropriate forecasting models. monte carlo simulation and risk analysis: monte carle simulation using analytic solver platform, new-product development model, newsvendor model, overbooking model, cash budget model.
Unit 5	**Decision analysis:** Formulating decision problems, decision strategies with the without outcome probabilities, decision trees, the value of information, utility and decision making.
Unit 6	**Recent trends in:** Embedded and collaborative business intelligence, visual data recovery, data storytelling and data journalism
Text/Reference Books:	
1.	Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press.
2.	Business Analytics by James Evans, persons Education.

List of Equivalent Subjects from SWAYAM/NPTEL for Credit Transfer

Sr. No.	Institute Course		Details of Course from SWAYAM/NPTEL
	Course Code	Title of the Course	
1.	OEC-801	Business Analytics	---

OEC-802	Industrial Safety	
Teaching scheme:		**Examination scheme:**
Lecture	3 hrs /week	Theory In Semester Evaluation : 20 Marks Mid Semester Examination: 30 Marks End Semester Examination: 50 Marks
Tutorial	--	
Practical	0 hrs/week	
Credit		

Course Objectives:	
1.	To study Industrial Safety
2.	To understand fundamentals of maintenance engineering.
3.	To understand Wear and corrosion and their prevention
4.	To study Fault tracing.
5.	To know principles of periodic and preventive maintenance.

Course Outcomes: On successful completion of this course, students will be able to	
1.	Know safety measures in Industry.
2.	Analyze wear and corrosions and their prevention of different machines.
3.	Know how preventive maintenance is carried out in industry.
4.	Analyze fault tracing techniques.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	1	2	-	-	-	-	-	-	-	3	3	2
CO2	3	2	2	3	2	-	-	-	-	-	-	-	3	2	2
CO3	2	3	2	3	2	-	-	-	-	-	-	-	3	3	2
CO4	2	2	3	2	2	-	-	-	-	-	-	-	3	3	2
CO (total)	9	8	8	9	8	-	-	-	-	-	-	-	12	11	8
CO(avg)	2	2	2	2	2	-	-	-	-	-	-	-	3	3	2

Syllabus	
Unit 1	**Industrial safety:** accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, safety color codes. fire prevention and firefighting, equipment and methods.
Unit 2	**Fundamentals of maintenance engineering:** Definition and aim of maintenance engineering, primary and secondary functions and responsibility of maintenance department, types of maintenance, types and applications of tools used for maintenance, maintenance cost and its relation with replacement economy, service life of equipment.
Unit 3	**Wear and corrosion and their prevention:** wear- types, causes, effects, wear reduction methods, lubricants-types and applications, lubrication methods, general sketch, working and applications, i. screw down grease cup, ii. pressure grease gun, iii. splash lubrication, iv. gravity lubrication, v. wick feed lubrication vi. side feed lubrication, vii. ring lubrication, definition, principle and factors affecting the corrosion. types of corrosion, corrosion prevention methods
Unit 4	**Fault tracing:** fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, i. any one machine tool, ii. pump iii. air compressor, iv. internal combustion engine, v. boiler, vi. electrical motors, types of faults in machine tools and their general causes
Unit 5	**Periodic and preventive maintenance:** periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. steps/procedure for periodic and preventive maintenance of: i. machine tools, ii. pumps, iii. air compressors, iv. diesel generating (DG) sets, program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. repair cycle concept and importance.
Text/Reference Books:	
1.	Maintenance Engineering Handbook, Higgins and Morrow, Da Information Services.
2.	Maintenance Engineering, H. P. Garg, S. Chand and Company
3.	Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.
4.	Foundation Engineering Handbook, Winterkorn, Hans, Chapman and Hall London.

List of Equivalent Subjects from SWAYAM/NPTEL for Credit Transfer

Sr. No.	Institute Course		Details of Course from SWAYAM/NPTEL
	Course Code	Title of the Course	
1.	OEC-802	Industrial Safety	---

OEC-803	Operations Research	
Teaching scheme:		**Examination scheme:**
Lecture	3 hrs /week	Theory In Semester Evaluation : 20 Marks Mid Semester Examination: 30 Marks End Semester Examination: 50 Marks
Tutorial	--	
Practical	0 hrs/week	
Credit		

Course Objectives:	
1.	To study optimization techniques.
2.	To study how to formulate an LPP - graphical solution for the problem.
3.	To study nonlinear programming problem.
4.	To understand Scheduling and sequencing.
5.	To understand competitive models.

Course Outcomes: On successful completion of this course, students will be able to	
1.	Apply the dynamic programming to solve problems of discreet and continuous variables.
2.	Apply the concept of non-linear programming.
3.	Carry out sensitivity analysis.
4.	Model the real world problem and simulate it.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	1	2	-	-	-	-	-	-	-	3	3	2
CO2	3	2	2	3	2	-	-	-	-	-	-	-	3	2	2
CO3	2	3	2	3	2	-	-	-	-	-	-	-	3	3	2
CO4	2	2	3	2	2	-	-	-	-	-	-	-	3	3	2
CO (total)	9	8	8	9	8	-	-	-	-	-	-	-	12	11	8
CO(avg)	2	2	2	2	2	-	-	-	-	-	-	-	3	3	2

Syllabus	
Unit 1	Optimization techniques, model formulation, models, general L.R formulation, simplex techniques, sensitivity analysis, inventory control models.
Unit 2	Formulation of a LPP - graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming.
Unit 3	Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT
Unit 4	Scheduling and sequencing - single server and multiple server models - deterministic inventory models - probabilistic inventory control models - geometric programming
Unit 5	Competitive models, single and multi-channel problems, sequencing models, dynamic programming, flow in networks, elementary graph theory, game theory simulation
Text/Reference Books:	
1.	H.A. Taha, Operations Research, An Introduction, PHI, 2008
2.	H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982
3.	J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4.	Hitler Libermann Operations Research: McGraw Hill Pub. 2009
5.	Pannerselvam, Operations Research: Prentice Hall of India 2010
6.	Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010

List of Equivalent Subjects from SWAYAM/NPTEL for Credit Transfer

Sr. No.	Institute Course		Details of Course from SWAYAM/NPTEL
	Course Code	Title of the Course	
1.	OEC-803	Operations Research	---

OEC-804	Cost Management of Engineering Projects	
Teaching scheme:		**Examination scheme:**
Lecture	3 hrs /week	Theory In Semester Evaluation : 20 Marks Mid Semester Examination: 30 Marks End Semester Examination: 50 Marks
Tutorial	--	
Practical	0 hrs/week	
Credit		

Course Objectives:	
1.	Understanding strategic cost management process.
2.	Learning cost concepts in decision-making.
3.	Understanding cost behavior and profit planning marginal costing.
4.	Learning quantitative techniques for cost management.
5.	Learning linear programming.
6.	Understanding PERT/CPM.
Course Outcomes: On successful completion of this course, students will be able to	
1.	Find strategic cost of the project.
2.	Make decision related to projects.
3.	Predict cost behavior of the project.
4.	Find time required for the project using PERT/CPM.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	1	2	-	-	-	-	-	-	-	3	3	2
CO2	3	2	2	3	2	-	-	-	-	-	-	-	3	2	2
CO3	2	3	2	3	2	-	-	-	-	-	-	-	3	3	2
CO4	2	2	3	2	2	-	-	-	-	-	-	-	3	3	2
CO (total)	9	8	8	9	8	-	-	-	-	-	-	-	12	11	8
CO(avg)	2	2	2	2	2	-	-	-	-	-	-	-	3	3	2

Syllabus	
Unit 1	Introduction and overview of the strategic cost management process.
Unit 2	Cost concepts in decision-making; relevant cost, differential cost, incremental cost and opportunity cost. objectives of a costing system; inventory valuation; creation of a database for operational control; provision of data for decision-making. project: meaning, different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. project execution as conglomeration of technical and nontechnical activities. detailed engineering activities. pre project execution main clearances and documents project team: role of each member. importance project site: data required with significance. project contracts. types and contents. project execution project cost control. bar charts and network diagram. project commissioning: mechanical and process.
Unit 3	Cost behavior and profit planning marginal costing; distinction between marginal costing and absorption costing; break-even analysis, cost-volume-profit analysis. various decision-making problems. standard costing and variance analysis. pricing strategies: pareto analysis. target costing, life cycle costing. costing of service sector. just-in-time approach, material requirement planning, enterprise resource planning, total quality management and theory of constraints. activity-based cost management, bench marking; balanced score card and value-chain analysis. budgetary control; flexible budgets; performance budgets; zero-based budgets. measurement of divisional profitability pricing decisions including transfer pricing.
Unit 4	Quantitative techniques for cost management, linear programming, PERT/CPM, transportation problems, assignment problems, simulation, learning curve theory.
Text/Reference Books:	
1.	Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi.
2.	Charles T. Horngren and George Foster, Advanced Management Accounting.
3.	Robert S Kaplan Anthony A. Alkinson, Management and Cost Accounting.
4.	Ashish K. Bhattacharya, Principles and Practices of Cost Accounting A. H. Wheeler publisher.
5.	N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

List of Equivalent Subjects from SWAYAM/NPTEL for Credit Transfer

Sr. No.	Institute Course		Details of Course from SWAYAM/NPTEL
	Course Code	Title of the Course	
1.	OEC-804	Cost Management of Engineering Projects	---

OEC-805	Composite Materials	
Teaching scheme:		**Examination scheme:**
Lecture	3 hrs /week	Theory In Semester Evaluation : 20 Marks Mid Semester Examination: 30 Marks End Semester Examination: 50 Marks
Tutorial	--	
Practical	0 hrs/week	
Credit		

Course Objectives:	
1.	To study characteristics of composite material.
2.	To learn Reinforcements of composite material.
3.	To study process of manufacturing of metal matrix composites.
4.	To learn process of manufacturing of polymer matrix composites.
5.	To study various techniques for estimating strength of composite material.
6.	To study stress concentrations.
Course Outcomes: On successful completion of this course, students will be able to	
1.	Categorize various composite materials based on their properties.
2.	Gain knowledge in manufacturing of metal matrix composites.
3.	Get knowledge of injection and moulding of composite material.
4.	To estimate strength of composite material.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	1	2	-	-	-	-	-	-	-	3	3	2
CO2	3	2	2	3	2	-	-	-	-	-	-	-	3	2	2
CO3	2	3	2	3	2	-	-	-	-	-	-	-	3	3	2
CO4	2	2	3	2	2	-	-	-	-	-	-	-	3	3	2
CO (total)	9	8	8	9	8	-	-	-	-	-	-	-	12	11	8
CO(avg)	2	2	2	2	2	-	-	-	-	-	-	-	3	3	2

Syllabus	
Unit 1	**Introduction:** definition – classification and characteristics of composite materials. advantages and application of composites. functional requirements of reinforcement and matrix. effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance
Unit 2	**Reinforcements:** Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, kevlar fibers and boron fibers. properties and applications of whiskers, particle reinforcements. mechanical behavior of composites: rule of mixtures, inverse rule of mixtures. isostrain and isostress conditions
Unit 3	**Manufacturing of metal matrix composites:** casting – solid state diffusion technique, cladding – hot isostatic pressing. properties and applications. manufacturing of ceramic matrix composites: liquid metal infiltration – liquid phase sintering. manufacturing of carbon – carbon composites: knitting, braiding, weaving. properties and applications
Unit 4	**Manufacturing of polymer matrix composites**: preparation of moulding compounds and prepregs – hand layup method – autoclave method – filament winding method – compression moulding – reaction injection moulding. properties and applications
Unit 5	**Strength:** Laminar failure criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. laminate first play failure-insight strength; laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations
Text/Reference Books:	
1.	Material Science and Technology – Vol 13 – Composites by R.W.Cahn – VCH, West Germany.
2.	Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R. Balasubramaniam, John Wiley and Sons, NY, Indian edition, 2007
3.	Hand Book of Composite Materials-ed-Lubin
4.	Composite Materials – K.K.Chawla
5.	Composite Materials Science and Applications – Deborah D.L. Chung
6.	Composite Materials Design and Applications – Danial Gay, Suong V. Hoa, and Stephen W. Tasi

List of Equivalent Subjects from SWAYAM/NPTEL for Credit Transfer

Sr. No.	Institute Course		Details of Course from SWAYAM/NPTEL
	Course Code	Title of the Course	
1.	OEC-805	Composite Materials	---

OEC-806	Waste to Energy	
Teaching scheme:		**Examination scheme:**
Lecture	3 hrs /week	Theory In Semester Evaluation : 20 Marks Mid Semester Examination: 30 Marks End Semester Examination: 50 Marks
Tutorial	--	
Practical	0 hrs/week	
Credit		

Course Objectives:	
1.	To learn classification of waste as fuel.
2.	To learn Biomass pyrolysis.
3.	To understand Biomass gasification.
4.	To learn Biomass combustion.
5.	To understand Biogas.
6.	To understand urban waste to energy conversion.

Course Outcomes: On successful completion of this course, students will be able to	
1.	Know waste as fuel.
2.	Learn slow fast – manufacture of charcoal, pyrolytic oils and gases.
3.	Design, construction, and operation of biomass gasification.
4.	Learn operation of biomass combustors.
5.	Learn bio diesel production and urban waste to energy conversion.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	1	2	-	-	-	-	-	-	-	3	3	2
CO2	3	2	2	3	2	-	-	-	-	-	-	-	3	2	2
CO3	2	3	2	3	2	-	-	-	-	-	-	-	3	3	2
CO4	2	2	3	2	2	-	-	-	-	-	-	-	3	3	2
CO5	3	3	2	3	2	-	-	-	-	-	-	-	3	2	2
CO (total)	12	11	10	12	10	-	-	-	-	-	-	-	15	13	10
CO(avg)	2	2	2	2	2	-	-	-	-	-	-	-	3	3	2

Syllabus	
Unit 1	Introduction to energy from waste: classification of waste as fuel – agro based, forest residue, industrial waste - MSW – conversion devices – incinerators, gasifiers, digestors.
Unit 2	Biomass pyrolysis: pyrolysis – types, slow fast – manufacture of charcoal – methods - yields and application – manufacture of pyrolytic oils and gases, yields and applications.
Unit 3	Biomass gasification: Gasifiers – fixed bed system – downdraft and updraft gasifiers – fluidized bed gasifiers – design, construction and operation – gasifier burner arrangement for thermal heating – gasifier engine arrangement and electrical power – equilibrium and kinetic consideration in gasifier operation.
Unit 4	Biomass combustion: biomass stoves – improved chullahs, types, some exotic designs, fixed bed combustors, types, inclined grate combustors, fluidized bed combustors, design, construction, and operation - operation of all the above biomass combustors.
Unit 5	Biogas: properties of biogas (calorific value and composition) - biogas plant technology and status - bio energy system - design and constructional features - biomass resources and their classification - biomass conversion processes - thermo chemical conversion - direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - types of biogas plants – applications - alcohol production from biomass - bio diesel production - urban waste to energy conversion - biomass energy programme in India.
Text/Reference Books:	
1.	Non-Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990
2.	Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I and II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3.	Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4.	Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley and Sons, 1996.

List of Equivalent Subjects from SWAYAM/NPTEL for Credit Transfer

Sr. No.	Institute Course		Details of Course from SWAYAM/NPTEL
	Course Code	Title of the Course	
1.	OEC-806	Waste to Energy	---

SEM-AI-524	Mini Project and Seminar	
Teaching scheme:		**Examination scheme:**
Lecture	0 hrs /week	He/She must deliver two presentations and demonstration of mini project during the semester. First one immediately after Mid Semester and second at the end of semester.
Tutorial	--	
Practical	4 hrs/week	
Credit	2	

Course Objectives:	
1.	To know various standard journals and conferences in related field.
2.	To know state-of-the -art research happenings in the field of interest.
3.	Opportunity to study and implement earlier technique.
4.	To present research work.
Course Outcomes: On successful completion of this course, students will be able to	
1.	Gain primary knowledge in related field.
2.	Get hands on experience by implementing mini project.
3.	Present research work carried out.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	1	2	-	-	-	-	-	-	-	3	3	2
CO2	3	2	2	3	2	-	-	-	-	-	-	-	3	2	2
CO3	2	3	2	3	2	-	-	-	-	-	-	-	3	3	2
CO (total)	7	6	5	7	6	-	-	-	-	-	-	-	9	8	6
CO(avg)	2	2	2	2	2	-	-	-	-	-	-	-	3	3	2

Structure/Syllabus:

Every student will be given mini project at the start of semester. He/she must work on the completion of the same under supervisor(s) allotted. Every student has to select the topic of seminar at the start of semester through searching of IEEE/IET/Springer/Elsevier/Other resources from latest publications in the field of Artificial Intelligence systems. He/She has to deliver two presentations during the semester I immediately after Mid Semester and second at the end of semester. A student may write a review paper based on the study that he performs during a semester.

AUD-901	Project Management	
Teaching scheme:		**Examination scheme:**
Lecture	2 hrs /week	Theory In Semester Evaluation : 20 Marks Mid Semester Examination: 30 Marks End Semester Examination: 50 Marks
Tutorial	0	
Practical	0 hrs/week	
Credit	0	

Course Objectives:	
1.	Understand the fundamental principles of Project management and have a good knowledge of responsibilities of project manager and how to handle these.
2.	To do the Project Scheduling, tracking, Risk analysis, Quality management and Project Cost estimation using different techniques
3.	To highlight different techniques for software cost estimation and activity planning

Course Outcomes: On successful completion of this course, students will be able to	
1.	Understand the concepts and functions of project management
2.	Apply the project plan planning and monitoring techniques.
3.	Analyze the project value, risk and quality.
4.	Design and develop projects at each stage of the software development life cycle (SDLC).

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	1	2	-	-	-	-	-	-	-	3	3	2
CO2	3	2	2	3	2	-	-	-	-	-	-	-	3	2	2
CO3	2	3	2	3	2	-	-	-	-	-	-	-	3	3	2
CO4	2	2	3	2	2	-	-	-	-	-	-	-	3	3	2
CO (total)	9	8	8	9	8	-	-	-	-	-	-	-	12	11	8
CO(avg)	2	2	2	2	2	-	-	-	-	-	-	-	3	3	2

Syllabus	
Unit 1	**Project Management:** Concept of Project Management, Principles of Project Management, Functions of Project Management: Planning, Organizing, Staffing, Directing & Controlling, Project Scope Verification, Functional & Matrix Organization Structure.
Unit 2	**Project Network Analysis:** Project Network Diagram: Precedence Diagramming Method (PDM), Activity-on-Node (AON) & Arrow Diagramming Method (ADM), Work Breakdown Structure (WBS), Gantt Chart, Milestone Chart, Project Network Analysis (Critical Path Method and PERT), Cost Analysis of Project, Resource Allocation, Resource Smoothening & Leveling, Resource Histograms, Use of Computer Software (PRIMAVERA & MICROSOFT PROJECT) in Project Network Analysis.
Unit 3	**Project Network Case Studies:** Thermal Power Project, Fertilizer Project, Turnkey Construction Project, Software Creation & Installation Project, Project Related to Mechanical Industry, Projects Related to Electronic & Communication Industry.
Unit 4	**Project Economics & Project Value Analysis:** Project Formulation, Project Plan, Project Appraisal Techniques: Net Present Value, Internal Rate of Return, Payback Period, Benefit Cost Ratio, Value Engineering job plan, Project Life Cycle Costs.
Unit 5	**Project Quality , Risk & Procurement Management:** Project Quality Planning, Assurance & Control, Project Quality Management Techniques: Kaizen & Just-inTime, Total Quality Management, Risk-Management Plan, Uncertainty, Risk Factors and Risk Tolerances, Project Quantitative Risk Analysis (Monte Carlo Analysis & Decision Tree), Project Risk Monitoring & Control, Procurement Management Plan, Project Contract Administration.
Unit 6	**Computerized Project Management:** Project Information Cell, Management Information System, Software Project Management, Categorization of Software Projects , Project portfolio Management, Software Process and Process Models, Choice of Process Models: Mental Delivery, Rapid Application Development, Agile Methods, Extreme Programming, SCRUM, Software Estimation, Effort and Cost Estimation Techniques, COSMIC Full Function Points, COCOMO II A Parametric Productivity Model, Project Tracking, Software Configuration Management, Staffing Pattern, Methods of staff selection, The Oldham-Hackman job characteristic model.
Text/Reference Books:	
1.	Chitkara K.K., Construction Project Management, Tata McGraw Hill Publications.
2.	Barrie D.S. & Paulson B.C,Professional Construction Management, McGraw Hill.
3.	R.Flagnan and G.Norman, Risk Managemnt & Construction, Blackwell Scientific Publishers.
4.	L.W. Zimmwerman and G.D. Hart, Value Engineering, CBS Publishers.
5.	Robert K. Wysocki "Effective Software Project Management" –Wiley Publication, 2011
6.	Walker Royce: "Software Project Management"-Addison-Wesley, 1998

List of Equivalent Subjects from SWAYAM/NPTEL for Credit Transfer

Sr. No.	Institute Course		Details of Course from SWAYAM/NPTEL
	Course Code	Title of the Course	
1.	AUD-901	Project Management	---

AUD-902	Disaster Management	
Teaching scheme:		**Examination scheme:**
Lecture	2 hrs /week	Theory In Semester Evaluation : 20 Marks Mid Semester Examination: 30 Marks End Semester Examination: 50 Marks
Tutorial	0	
Practical	0 hrs/week	
Credit	0	

Course Objectives:	
1.	Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
2.	Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
3.	Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
4.	Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they working.

Course Outcomes: On successful completion of this course, students will be able to	
1.	Know manmade and natural disasters.
2.	Estimate loss of human and animal life.
3.	Identify disaster-prone areas.
4.	Develop method for preparedness in disaster management.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	1	2	-	-	-	-	-	-	-	3	3	2
CO2	3	2	2	3	2	-	-	-	-	-	-	-	3	2	2
CO3	2	3	2	3	2	-	-	-	-	-	-	-	3	3	2
CO4	2	2	3	2	2	-	-	-	-	-	-	-	3	3	2
CO (total)	9	8	8	9	8	-	-	-	-	-	-	-	12	11	8
CO(avg)	2	2	2	2	2	-	-	-	-	-	-	-	3	3	2

Syllabus	
Unit 1	**Introduction:** Definition, Factors and Significance; Difference between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.
Unit 2	**Repercussions of Disasters and Hazards**: Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.
Unit 3	**Disaster Prone Areas In India Study Of Seismic Zones**; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics.
Unit 4	**Disaster Preparedness and Management Preparedness:** Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness
Unit 5	**Risk Assessment Disaster Risk**: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival
Unit 6	Disaster Mitigation Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends in Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs Of Disaster Mitigation in India.
Text/Reference Books:	
1.	R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company.
2.	Sahni, PardeepEt.Al. (Eds.)," Disaster Mitigation Experiences and Reflections", Prentice Hall Of India, New Delhi.
3.	Goel S. L. "Disaster Administration and Management Text and Case Studies", Deep & Deep Publication Pvt. Ltd., New Delhi.

List of Equivalent Subjects from SWAYAM/NPTEL for Credit Transfer

Sr. No.	Institute Course		Details of Course from SWAYAM/NPTEL
	Course Code	Title of the Course	
1.	AUD-902	Disaster Management	---

AUD-903	Sanskrit for Technical Knowledge	
Teaching scheme:		**Examination scheme:**
Lecture	2 hrs /week	Theory In Semester Evaluation : 20 Marks Mid Semester Examination: 30 Marks End Semester Examination: 50 Marks
Tutorial	0	
Practical	0 hrs/week	
Credit	0	

Course Objectives:	
1.	To get a working knowledge in illustrious Sanskrit, the scientific language in the world
2.	Learning of Sanskrit to improve brain functioning 3. Learning of Sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power.
3.	The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature.
Course Outcomes: On successful completion of this course, students will be able to	
1.	Understanding basic Sanskrit language.
2.	Ancient Sanskrit literature about science & technology can be understood
3.	Being a logical language will help to develop logic in students

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	1	2	-	-	-	-	-	-	-	3	3	2
CO2	3	2	2	3	2	-	-	-	-	-	-	-	3	2	2
CO3	2	3	2	3	2	-	-	-	-	-	-	-	3	3	2
CO (total)	7	6	5	7	6	-	-	-	-	-	-	-	9	8	6
CO(avg)	2	2	2	2	2	-	-	-	-	-	-	-	3	3	2

Syllabus	
Unit 1	Alphabets in Sanskrit.
Unit 2	Past/Present/Future Tense
Unit 3	Simple Sentences, Order
Unit 4	Introduction of roots
Unit 5	Technical information about Sanskrit Literature
Unit 6	Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics
Text/Reference Books:	
1.	"Abhyaspustakam" – Dr.Vishwas, Samskrita-Bharti Publication, New Delhi
2.	"Teach Yourself Sanskrit" PrathamaDeeksha-VempatiKutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication.
3.	"India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi

List of Equivalent Subjects from SWAYAM/NPTEL for Credit Transfer

Sr. No.	Institute Course		Details of Course from SWAYAM/NPTEL
	Course Code	Title of the Course	
1.	AUD-903	Sanskrit for Technical Knowledge	---

AUD-904	Value Education	
Teaching scheme:		**Examination scheme:**
Lecture	2 hrs /week	Theory In Semester Evaluation : 20 Marks Mid Semester Examination: 30 Marks End Semester Examination: 50 Marks
Tutorial	0	
Practical	0 hrs/week	
Credit	0	

Course Objectives:	
1.	Understand value of education and self- development.
2.	Imbibe good values in students
3.	Should know about the importance of character
Course Outcomes: On successful completion of this course, students will be able to	
1.	Have knowledge of self-development
2.	Learn the importance of Human values.
3.	Developing the overall personality.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	1	2	-	-	-	-	-	-	-	3	3	2
CO2	3	2	2	3	2	-	-	-	-	-	-	-	3	2	2
CO3	2	3	2	3	2	-	-	-	-	-	-	-	3	3	2
CO (total)	7	6	5	7	6	-	-	-	-	-	-	-	9	8	6
CO(avg)	2	2	2	2	2	-	-	-	-	-	-	-	3	3	2

Syllabus	
Unit 1	Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non- moral valuation. Standards and principles. Value judgements, Importance of cultivation of values.
Unit 2	Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature, Discipline.
Unit 3	Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking.
Unit 4	Free from anger, Dignity of labor, Universal brotherhood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits, Association and Cooperation.
Unit 5	Doing best for saving nature, Character and Competence –Holy books vs Blind faith. Self-management and Good health. Science of reincarnation
Unit 6	Equality, Nonviolence, Humility, Role of Women. All religions and same message, Mind your Mind, Self-control. Honesty, studying effectively
Text/Reference Books:	
1.	Chakroborty, S.K. "Values and Ethics for organizations Theory and practice", Oxford University Press, New Delhi.

List of Equivalent Subjects from SWAYAM/NPTEL for Credit Transfer

Sr. No.	Institute Course		Details of Course from SWAYAM/NPTEL
	Course Code	Title of the Course	
1.	AUD-904	Value Education	---

AUD-905	Constitution of India	
Teaching scheme:		**Examination scheme:**
Lecture	2 hrs /week	Theory
Tutorial	0	In Semester Evaluation : 20 Marks
Practical	0 hrs/week	Mid Semester Examination: 30 Marks
Credit	0	End Semester Examination: 50 Marks

Course Objectives:	
1.	To learn history of Indian Constitution.
2.	To learn philosophy of the Indian Constitution.
3.	To know contours of Constitutional Rights & Duties
4.	To learn organs of Indian Governance.
5.	To learn local administration in India.
6.	To learn rights and duties of Election Commission of India.

Course Outcomes: On successful completion of this course, students will be able to	
1.	Know Indian constitution drafting committee composition and working.
2.	Know fundamental rights and their duties.
3.	Know parliament and judiciary system of India.
4.	Know how local governance happens in India right from village gram panchayat to Parliament.
5.	Know working and function of Election Commission of India.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	1	2	-	-	-	-	-	-	-	3	3	2
CO2	3	2	2	3	2	-	-	-	-	-	-	-	3	2	2
CO3	2	3	2	3	2	-	-	-	-	-	-	-	3	3	2
CO4	2	2	3	2	2	-	-	-	-	-	-	-	3	3	2
CO5	3	3	2	3	2	-	-	-	-	-	-	-	3	2	2
CO (total)	12	11	10	12	10	-	-	-	-	-	-	-	15	13	10
CO(avg)	2	2	2	2	2	-	-	-	-	-	-	-	3	3	2

Syllabus	
Unit 1	History of Making of the Indian Constitution: History Drafting Committee, (Composition & Working).
Unit 2	Philosophy of the Indian Constitution: Preamble Salient Features.
Unit 3	Contours of Constitutional Rights & Duties: Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy , Fundamental Duties.
Unit 4	Organs of Governance: Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.
Unit 5	Local Administration: District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy
Unit 6	Election Commission: Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.
Text/Reference Books:	
1.	The Constitution of India, 1950 (Bare Act), Government Publication.
2.	Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3.	M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4.	D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

List of Equivalent Subjects from SWAYAM/NPTEL for Credit Transfer

Sr. No.	Institute Course		Details of Course from SWAYAM/NPTEL
	Course Code	Title of the Course	
1.	AUD-905	Constitution of India	---

AUD-906	Pedagogy Studies	
Teaching scheme:		**Examination scheme:**
Lecture	2 hrs /week	Theory In Semester Evaluation : 20 Marks Mid Semester Examination: 30 Marks End Semester Examination: 50 Marks
Tutorial	0	
Practical	0 hrs/week	
Credit	0	

Course Objectives:	
1.	To understand theories of learning.
2.	To learn evidence on the effectiveness of pedagogical practices.
3.	To learn alignment with classroom practices and follow-up support.
4.	To know how to design Curriculum and do assessment.
5.	To learn how to carry out research.
6.	To learn pedagogic theory and pedagogical approaches

Course Outcomes: On successful completion of this course, students will be able to	
1.	Know how effective learning happens.
2.	Design curriculum and best assessment
3.	Find research gap and continue research work.
4.	Adapt best teaching practices.
5.	Increase effectiveness in teaching.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	1	2	-	-	-	-	-	-	-	3	3	2
CO2	3	2	2	3	2	-	-	-	-	-	-	-	3	2	2
CO3	2	3	2	3	2	-	-	-	-	-	-	-	3	3	2
CO4	2	2	3	2	2	-	-	-	-	-	-	-	3	3	2
CO5	3	3	2	3	2	-	-	-	-	-	-	-	3	2	2
CO (total)	12	11	10	12	10	-	-	-	-	-	-	-	15	13	10
CO(avg)	2	2	2	2	2	-	-	-	-	-	-	-	3	3	2

Syllabus	
Unit 1	Introduction and Methodology: Aims and rationale, Policy background, Conceptual framework and terminology, Theories of learning, Curriculum, Teacher education. Conceptual framework, Research questions, Overview of methodology and Searching. Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries, Curriculum, Teacher education.
Unit 2	Evidence on the effectiveness of pedagogical practices, Methodology for the in depth stage: quality assessment of included studies, How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?, Theory of change, Strength and nature of the body of evidence for effective pedagogical practices, Pedagogic theory and pedagogical approaches, Teachers' attitudes and beliefs and Pedagogic strategies.
Unit 3	Professional development: alignment with classroom practices and follow-up support, Peer support from the head teacher and the community, Curriculum and assessment, Barriers to learning limited resources and large class sizes.
Unit 4	Research gaps and future directions, Research design, Contexts, Pedagogy, Teacher education, Curriculum and assessment, Dissemination, and research impact.
Text/Reference Books:	
1.	Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261
2.	Agrawal M (2004) curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.
3.	Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
4.	Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.
5.	Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell
6.	Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.
7.	www.pratham.org/images/resource%20working%20paper%202.pdf.

List of Equivalent Subjects from SWAYAM/NPTEL for Credit Transfer

Sr. No.	Institute Course		Details of Course from SWAYAM/NPTEL
	Course Code	Title of the Course	
1.	AUD-906	Pedagogy Studies	---

AUD-907	Stress Management by ancient Indian Techniques	
Teaching scheme:		**Examination scheme:**
Lecture	2 hrs /week	Theory In Semester Evaluation : 20 Marks Mid Semester Examination: 30 Marks End Semester Examination: 50 Marks
Tutorial	0	
Practical	0 hrs/week	
Credit	0	

Course Objectives:	
1.	To achieve overall health of body and mind.
2.	To overcome stress.
3.	To have knowledge of theoretical and practical aspect of Yoga.
4.	To learn various techniques of Asan and Pranayam.
5.	To learn regularization of breathing techniques

Course Outcomes: On successful completion of this course, students will be able to	
1.	Develop healthy mind in a healthy body thus improving social health.
2.	Improve working efficiency.
3.	Get control over breathing.
4.	Enjoy dieses free life after daily practice of yoga.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	1	2	-	-	-	-	-	-	-	3	3	2
CO2	3	2	2	3	2	-	-	-	-	-	-	-	3	2	2
CO3	2	3	2	3	2	-	-	-	-	-	-	-	3	3	2
CO4	2	2	3	2	2	-	-	-	-	-	-	-	3	3	2
CO (total)	9	8	8	9	8	-	-	-	-	-	-	-	12	11	8
CO(avg)	2	2	2	2	2	-	-	-	-	-	-	-	3	3	2

Syllabus	
Unit 1	Definitions of Eight parts of yog. (Ashtanga), Yam and Niyam. Do`s and Don't's in life.
Unit 2	Ahinsa, satya, astheya, bramhacharya and aparigraha, Shaucha, Santosh, tapa, swadhyay, ishwarpranidhan.
Unit 3	Asan and Pranayami Various yog poses and their benefits for mind & body.
Unit 4	Regularization of breathing techniques and its effects-Types of pranayama.
Text/Reference Books:	
1.	"Yogic Asanas for Group Tarining-Part-I": Janardan Swami Yogabhyasi Mandal, Nagpur.
2.	"Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

List of Equivalent Subjects from SWAYAM/NPTEL for Credit Transfer

Sr. No.	Institute Course		Details of Course from SWAYAM/NPTEL
	Course Code	Title of the Course	
1.	AUD-907	Stress Management by ancient Indian Techniques	---

AUD-908	Personality Development through Life Enlightenment Skills	
Teaching scheme:		**Examination scheme:**
Lecture	2 hrs /week	Theory In Semester Evaluation : 20 Marks Mid Semester Examination: 30 Marks End Semester Examination: 50 Marks
Tutorial	0	
Practical	0 hrs/week	
Credit	0	

Course Objectives:	
1.	To learn to achieve the highest goal happiness.
2.	To become a person with stable mind, pleasing personality, and determination.
3.	To awaken wisdom in students.
4.	Study of Shrimad-Bhagwad-Geeta for developing his personality and achieve the highest goal in life
5.	Study of Neetishatakam for developing versatile personality

Course Outcomes: On successful completion of this course, students will be able to	
1.	develop his/her personality and achieve the highest goal in life
2.	lead the nation and mankind to peace and prosperity.
3.	develop versatile personality.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	1	2	-	-	-	-	-	-	-	3	3	2
CO2	3	2	2	3	2	-	-	-	-	-	-	-	3	2	2
CO3	2	3	2	3	2	-	-	-	-	-	-	-	3	3	2
CO (total)	7	6	5	6	6	-	-	-	-	-	-	-	9	8	6
CO(avg)	2	2	2	2	2	-	-	-	-	-	-	-	3	3	2

Syllabus	
Unit 1	Neeti satakam-Holistic development of personality.
Unit 2	Approach to day to day work and duties.
Unit 3	Statements of basic knowledge, Personality of Role model.
Text/Reference Books:	
1.	"Srimad Bhagavad Gita" by Swami Swarupananda Advaita Ashram (Publication Department), Kolkata.
2.	Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi.

List of Equivalent Subjects from SWAYAM/NPTEL for Credit Transfer

Sr. No.	Institute Course		Details of Course from SWAYAM/NPTEL
	Course Code	Title of the Course	
1.	AUD-908	Personality Development through Life Enlightenment Skills	---

DIS-AI-601	Dissertation Phase-I	
Teaching scheme:		**Examination scheme:**
Lecture	0 hrs /week	1. Candidates need to report weekly progress to his/her supervisor by maintain dairy/notebook for record of dissertation work. **2.** Every candidate should present himself (for about 30 min.) before the panel of examiners consisting of Head of Department, M. Tech. Coordinator or his nominee, all supervisors to evaluate the mid-term and end term performance of dissertation phase-I
Tutorial	0	
Practical	28 hrs/week	
Credit	4	

Dissertation shall consist of: Research work done by the candidate in the areas related to the chosen specialization, or Comprehensive and critical review of any recent development in the chosen specialization, or Design and/or development of a product related to the program done by the candidate.

Following shall be the guidelines for evaluation of dissertation phase I

- Project work / Thesis / Dissertation shall be carried out under the supervision of a qualified teacher in the concerned Department.
- A student may however, in certain cases, be permitted to work for the project in an Industrial/Research Organization, on the recommendation of the Head of the Department. In such cases, the project work shall be jointly supervised by a faculty of the Department and an Engineer / Scientist from the organization and the student shall be instructed to meet the faculty periodically and to attend the review committee meetings for evaluating the progress.
- Project work / Thesis / Dissertation shall be pursued for a minimum of 28hrs/week during the semester.
- Dissertation Phase-I shall consist of the following components (whichever applicable) Extensive literature survey, Data collection from R&D organizations, Industries, etc. Study of the viability, applicability and scope of the dissertation Detailed Design (H/W and S/W as applicable), Partial implementation.
- A candidate should prepare the following documents for examination:
    a. A term paper in the format of any standard journal based on the work.
    b. A detailed report of the work done by the candidate related to dissertation.
    c. Every candidate should present himself (for about 30 min.) before the panel of examiners (which will evaluate the dissertation phase-I for TW and Oral marks) consisting of Head of Department, M. Tech. Coordinator or his nominee, all supervisors.

DIS-AI-602	Dissertation Phase-II	
Teaching scheme:		**Examination scheme:**
Lecture	0 hrs /week	1. Candidates need to report weekly progress to his/her supervisor by maintain dairy/notebook for record of dissertation work. 2. The final examination (viva-voce) shall consist of a defense presented by the candidate on his/her work in the presence of examiners appointed by the University/Institute one of whom will be the supervisor and the other an external examiner.
Tutorial	0	
Practical	28 hrs/week	
Credit	4	

- Project work / Thesis / Dissertation (Phase - II) shall be pursued for a minimum of 28 hrs/week during the final semester, following the preliminary work carried out in Phase-1 during the previous semester.
- The Project Report/Thesis / Dissertation report should be prepared according to approved guidelines and duly signed by the supervisor(s), M. Tech Coordinator and the Head of the Department shall be submitted to the concerned department.
- The candidate shall submit the dissertation in triplicate to the Head of the institution, duly certified that the work has been satisfactorily completed.
- The dissertation shall be assessed internally by a panel of examiners (like the one in dissertation phase- I) before submission.
- The final examination (viva-voce) shall consist of a defense presented by the candidate on his/her work in the presence of examiners appointed by the University/Institute, one of whom will be the supervisor and the other an external examiner.

List of Equivalent Subjects from SWAYAM/NPTEL for Credit Transfer

Sr. No.	Institute Course		Details of Course from SWAYAM/NPTEL
	Course Code	Title of the Course	
Semester- I			
1.	PCC-AI-501	Artificial Neural Network and Applications	https://swayam.gov.in/nd1_noc20_cs50/preview
2.	PCC-AI-502	Digital Image and Video Processing	https://nptel.ac.in/courses/117/105/117105079/
3.	PCC-AI-503	Statistical Machine Learning	https://nptel.ac.in/courses/106/106/106106139/
4.	PEC-AI-507	Cyber Security	https://swayam.gov.in/nd2_cec20_cs15/preview
5.	PEC-AI-508	Speech Processing	https://nptel.ac.in/courses/117/105/117105145/
6.	PEC-AI-509	Big Data Analytics	https://swayam.gov.in/nd1_noc20_cs92/preview
7.	PEC-AI-512	Data Structure and Algorithm	https://nptel.ac.in/courses/106/102/106102064/#
Semester-II			
1.	PCC-AI-514	Natural Language Processing	https://swayam.gov.in/nd1_noc19_cs56/preview
2.	PCC-AI-515	Intelligent System	https://nptel.ac.in/courses/106/105/106105077/
3.	PEC-AI-516	Data Warehousing and Data Mining	https://nptel.ac.in/courses/106/105/106105174/
4.	PEC-AI-518	Wavelets and Applications	http://www.nptelvideos.in/2012/12/advanced-digital-signal-processing.html
5.	PEC-AI-521	Soft Computing and Applications	https://swayam.gov.in/nd1_noc20_cs17/preview
6.	PEC-AI-523	Foundation of Cognitive Robotics	https://swayam.gov.in/nd1_noc20_me92/preview https://nptel.ac.in/noc/courses/noc20/SEM2/noc20-me92/