CURRICULUM AND DETAILED SYLLABI

OF FOUNDATION ELECTIVES

FOR

B.E / B.Tech. DEGREE PROGRAMMES

FOR THE STUDENTS ADMITTED IN THE
ACADEMIC YEAR 2015-16 ONWARDS

THIAGARAJAR COLLEGE OF ENGINEERING
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THIAGARAJAR COLLEGE OF ENGINEERING MADURAI 625015
B.E / B.Tech. Degree Programmes

FOUNDATION ELECTIVES COURSES OF STUDY

(For the students admitted in the academic year 2015-2016 onwards)

Course Code	COURSE TITLE	Category	No. of Hours /Week			Credits
			L	T	P	
14MAFA0	GRAPH THEORY	FE	3	0	0	3
14MAFB0	FUZZY SETS AND CLUSTERING	FE	3	0	0	3
14MAFC0	NUMBER THEORY	FE	3	0	0	3
14 PHFA0	SMART MATERIALS FOR ENGINEERS	FE	3	0	0	3
14PHFB0	THINFILM TECHNOLOGY	FE	3	0	0	3
14PHFC0	NANOTECHNOLOGY	FE	3	0	0	3
14CHFA0	BIOLOGY FOR ENGINEERS	FE	3	0	0	3
14CHFB0	CHEMISTRY OF ENGINEERING MATERIALS	FE	3	0	0	3
14CHFC0	BATTERY TECHNOLOGIES	FE	3	0	0	3

FE: Foundation Elective

L : Lecture

T: Theory

P: Practical

Note:

1 Hour Lecture is equivalent to 1 credit

2 Hours Tutorial is equivalent to 1 credit

2 Hours Practical is equivalent to 1 credit

SCHEME OF EXAMINATION

SL NO	COURSE CODE *	NAME OF THE SUBJECT*	DURATION OF TERMINAL EXAM	MARKS			MINIMUM MARKS FOR PASS	
			IN HOURS	CA**	TE***	Max.	TE	Total
THEORY								
1	14MAFA0	GRAPH THEORY	3	50	50	100	25	50
2	14MAFB0	FUZZY SETS AND CLUSTERING	3	50	50	100	25	50
3	14MAFC0	NUMBER THEORY	3	50	50	100	25	50
4	14 PHFA0	SMART MATERIALS FOR ENGINEERS	3	50	50	100	25	50
5	14PHFB0	THINFILM TECHNOLOGY	3	50	50	100	25	50
6	14PHFC0	NANOTECHNOLOGY	3	50	50	100	25	50
7	14CHFA0	BIOLOGY FOR ENGINEERS	3	50	50	100	25	50
8	14CHFB0	CHEMISTRY OF ENGINEERING MATERIALS	3	50	50	100	25	50
9	14CHFC0	BATTERY TECHNOLOGIES	3	50	50	100	25	50

CA: Continuous Assessment

TE : Terminal Examination

* All B.E/B.Tech students has to register compulsorily two Foundation Electives mentioned above during their course of study

** CA Evaluation pattern will differ from course to course and for different tests. This will have to be declared in advance to the students. The department will form a process in place to ensure that the actual test paper will follow the declared pattern .

*** Terminal Examination will be conducted for maximum marks of 100 and subsequently be reduced to 50marks for the award of terminal examination marks.

14MAFA0 GRAPH THEORY

Category	L	T	P	Credit
FE	3	0	0	3

Preamble

An engineering student needs to have some basic mathematical tools and techniques to apply in diverse applications in Engineering. This emphasizes the development of rigorous logical thinking and analytical skills of the student and appraises him the complete procedure for solving different kinds of problems that occur in engineering. Combinatorial arguments are made a little easier by the use of pictures of the graphs. Natural form of graphs is a set with logical or hierarchical sequencing, such as computer flow charts. The concept of Graph Theory has wide range of applications in Networks, computer architecture, compiling techniques, model checking, artificial intelligence, software engineering, expert systems, software/hardware correctness problem, , DBMS, designing concepts, storage methods etc.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course, students will be able to

CO1:	Explain the types of graphs and illustrate isomorphism on graphs	Apply
CO2:	Explain the planarity of graphs and the classes of trees with properties	Apply
CO3:	Identify the adjacency and incidence matrix for the given graph and list its properties.	Apply
CO4:	Estimate the Chromatic partition, Chromatic polynomial and Matching of a given graph.	Apply
CO5:	Classify the types of directed graphs with its properties	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**S**	**L**	**S**	**S**	**S**							**L**
CO2	**M**	**M**	**M**	**S**	**S**							**L**
CO3	**L**	**L**	**L**	**M**	**S**							**L**
CO4	**M**	**L**	**L**	**L**	**S**							**L**
CO5	**S**	**S**	**S**	**S**	**S**							**L**

S- Strong; M-Medium; L-Low

Assessment Pattern

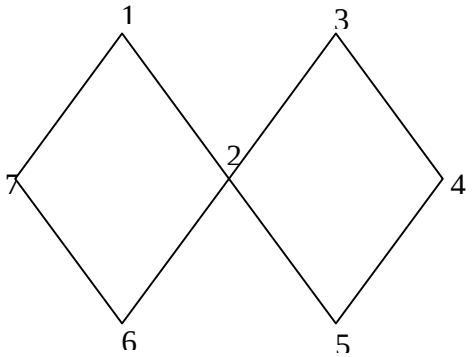
Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	10	10	10	10
Understand	20	20	20	20
Apply	70	70	70	70
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

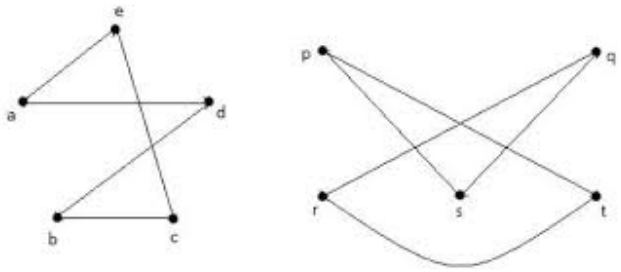
Course Outcome (CO1):

1. Construct a connected and disconnected graph with 10 vertices

2. Identify the induced sub graph and spanning sub graph of the following graph



3. Are the two graphs in the following figure isomorphic? Justify



Course Outcome (CO2):

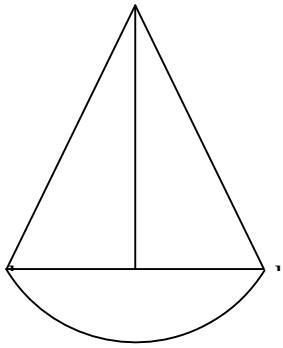
1. Identify which types of trees are complete bipartite graph?
2. Apply the concept of planarity in K_5 and $K_{3,4}$.
3. Let T=(V,E) be a tree with n-points $n \geq 2$. Then show that the number of pendant vertices in T is equal to $2 + \sum [\deg v_i - 2]$, $\deg v_i \geq 3$

Course Outcome (CO3):

1. Examine the graph whose adjacency matrix is given below to see if is connected.

$$\begin{pmatrix} 1 & 0 & 1 & 1 \\ 0 & 1 & 0 & 1 \\ 1 & 1 & 0 & 0 \\ 1 & 0 & 0 & 1 \end{pmatrix}$$

2. Use an incidence matrix to represent the following graph.

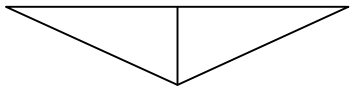


3. Demonstrate the properties of adjacency and incidence matrix of a graph G.

Course Outcome (CO4):

1. Compute the chromatic polynomial of the following graph
   (i) C_5 (ii) P_6 (III) $D_{3,4}$

2. Calculate the possible chromatic partitions for the following graph.

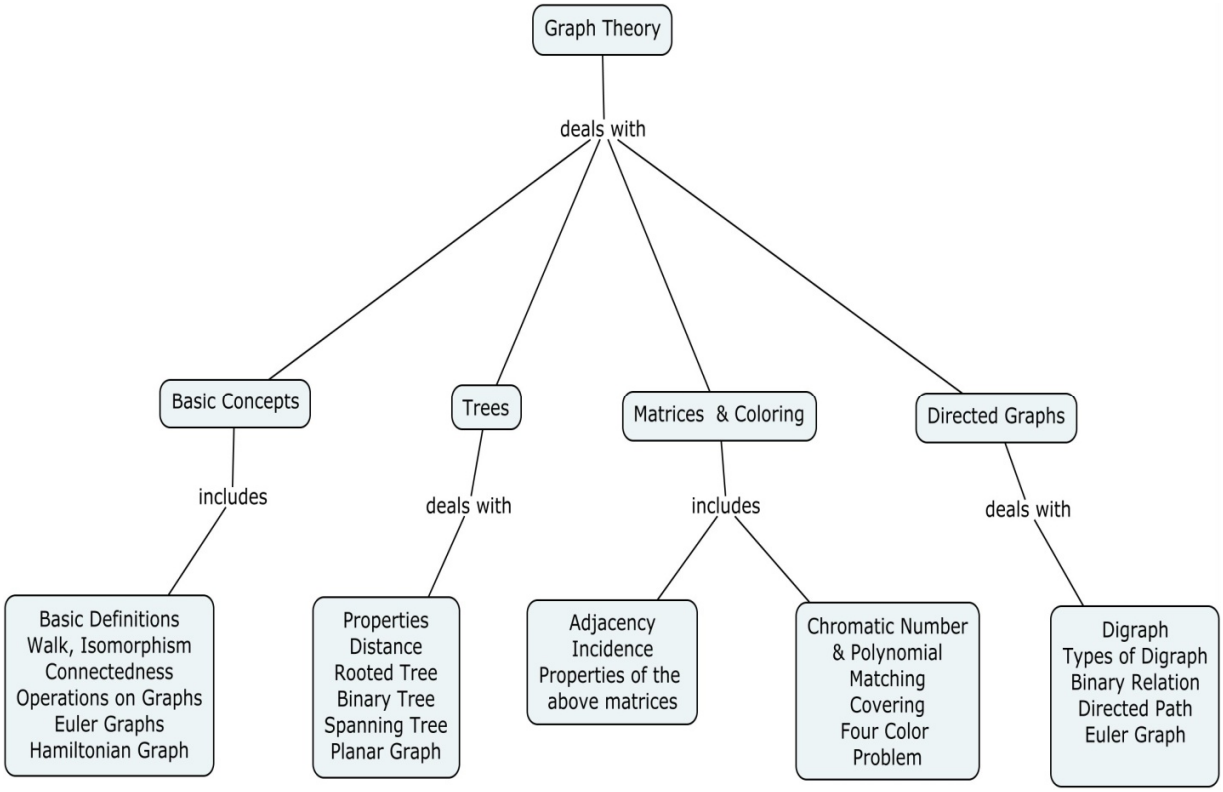


3.Compute Matching and covering number of Petersen graph.

Course Outcome (CO5):

1. Give an example for directed graph that corresponds to the symmetric relation. Check whether it is transitive.
2. Prove that every Euler digraph is strongly connected.
3. Give an example of an Euler digraph which is connected and balanced.

Concept Map



Syllabus

INTRODUCTION: Basic definitions in graphs, Walk, path, circuits, isomorphism, Connected and disconnected graph. Operations on graphs , Eulerian graph – Hamiltonian graph

TREES (CONNECTIVITY) PLANARITY: Properties of trees – distance and centers in tree – Applications- Rooted and binary trees, Spanning trees – Planar graphs – Different representation of a planar graph.

MATRICES AND COLORING: Adjacency matrix and its properties , incidence matrix and its properties, Chromatic number – Chromatic partitioning – Chromatic polynomial – Matching – Covering –four color problem (statement only) and its simple Applications.

DIRECTED GRAPHS : Directed graphs – Types of directed graphs – digraphs & its properties and binary relations – directed paths and connectedness – Euler graphs.

Text Book

1. Narsingh Deo, "Graph Theory: With Application to Engineering and Computer Science", Prentice Hall of India, 2013

2.. J.A.Bondy and USR.Moorthy, "Graph Theory with Applications", 2nd edition, Indian Reprint, Springer Publishers, 2015.

Reference Books

1. Frank Harary, "Graph Theory", Narosa Publishers, New Delhi, 1989
2. William Kocay & Donald.L,. Kreher, "Graphs, Algorithm and Optimization", CRT Press, 2005.
3. K.Thulasiraman & MNS.Swamy, "Graphs: Theory and Algorithms", John Wliey & sons Publication, 1992.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1	**INTRODUCTION**	
1.1	Basic definitions in graphs	2
1.2	Walk, path, circuits	1
1.3	Isomorphism	1
1.4	Connected and disconnected graph	2
1.5	Operations on graphs	2
1.6	Eulerian graph	2
1.7	Hamiltonian graph	2
2	**TREES (CONNECTIVITY) PLANARITY**	
2.1	Properties of trees	2
2.2	distance and centers in tree – Rooted and binary trees	1
2.3	Spanning trees	1
2.4	Planar graphs.	2
2.5	Different representation of a planar graph	2
3	**MATRICES AND COLORING**	
3.1	Adjacency matrix and its properties	1
3.2	incidence matrix and its properties	1
3.3	Chromatic number	1
3.4	Chromatic partitioning	1
3.5	Chromatic polynomial	2
3.6	Matching	1
3.7	Covering	1
3.8	Four color problem, Applications	1
4	**DIRECTED GRAPH** :	1
4.1	Directed graphs – Types of directed graphs	1
4.2	Digraphs -properties	1
4.3	Directed paths and connectedness	2
4.4	Binary relations, Euler graphs.	2
	Total hours	**36**

Course Designers:

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		Category	L	T	P	Credit
14MABB0	**FUZZY SETS AND CLUSTERING**	BS	3	0	0	3

Preamble

Fuzzy set theory provides a major newer paradigm in modeling and reasoning with uncertainty. Evolution of fuzzy mathematics has added promising new dimensions to the development of research and technology. The main objective of this course is to introduce the basic concepts of fuzzy sets which include representations & operations of fuzzy set, fuzzy relations and fuzzy classifications. These topics have wide range of applications in engineering, biology, medicine, psychology, economics, and many other disciplines.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course, students will be able to

CO1:	Calculate support, heights, normal alpha cuts and strong alpha cuts from the constructed membership functions.	Apply
CO2	Manipulate standard fuzzy operations such as complement, t-norm, t-conorm.	Apply
CO3:	Compute fuzzy relations for equivalence and compatibility.	Apply
CO4:	Experiment clustering and its analysis using Hard c-means and Fuzzy c-means.	Understand

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1.	**S**	**M**	**L**	**L**					**M**			**L**
CO2.	**S**	**M**	**L**	**L**					**M**			**L**
CO3.	**S**	**M**	**L**	**L**					**M**			**L**
CO4.	**S**	**M**	**L**	**M**	**L**				**M**			**S**

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	10	10	10	0
Understand	20	20	20	30
Apply	70	70	70	70
Analyze	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome (CO1):

1. Produce the difference between randomness and fuzziness.
2. Sequence the fuzzy sets defined by the following membership function(x>0) by the inclusion relation:

$$A(x)=\frac{1}{1+10x};\ A(x)=\left(\frac{1}{1+10x}\right)^{1/2};\ A(x)=\left(\frac{1}{1+10x}\right)^{2}$$

3. Consider the fuzzy sets A,B,C defined on the interval X=[0,10] of real numbers by the membership grade functions

$$A(x)=\frac{x}{x+2};B(x)=2^{-x};\ C(x)=\frac{1}{1+10(x-2)^2}$$

Calculate the α-cuts and strong α-cuts , support , height and normal of the three fuzzy sets defined above for α = 0.2,0.5,0.8,1.

4. Let the membership function be $B(x)=2^{-x}$ be defined on the universal set {0,1,2,3,4,5,6,7,8,9,10} and let f(x)=x^2 for all x€X. Compute F(B) using extension principle.
5. Explain why the law of contradiction and the law of exclusive middle are violated in fuzzy set theory under the standard fuzzy operations with its significance
6. Show that the following operations satisfy law of excluded middle and the law of contradiction u(a,b) = min(1,a+b), i(a,b) = max(0,a+b-1), c(a)=1-a .
7. Consider the fuzzy sets A,B,C defined on the interval X=[0,10] of real numbers by the membership grade functions

$$A(x)=\frac{x}{x+2};B(x)=2^{-x};\ C(x)=\frac{1}{1+10(x-2)^2}$$

Produce graphs of the membership grade functions of each of the following:

(i) $\bar{A},\bar{B},\bar{C}$ (ii) AUB,AUC,BUC (iii) $\bar{A}\mathrm{I}\ C,\bar{B}\mathrm{I}\ A,C\,\bar{\mathrm{I}}\ A$.

Course Outcome (CO2):

1. Given a fuzzy set D defined on {0,1,4,9,16,…,100} by $D=0.5/4+0.6/16+0.7/25+1/100$ Compute f^{-1}(D)
2. Produce axioms of t-norms and t-conorms.
3. Experiment which of the following functions is an increasing generator, if so compute the fuzzy t-norm, fuzzy t-conorm generated by it.

(i)g(a) = sin(a), (ii) g(a)=1+a ; (iii) g(a) = $\begin{cases} a;\ for\ 0\le a\le \frac{1}{2} \\ \frac{1}{2};\ for\ \frac{1}{2}<a\le 1 \end{cases}$

4.The fuzzy relations R is defined on sets X_1 ={a,b,c} ;X_2={s,t} ,X_3={x,y} ; X_4={i,j} as follows.

R(X_1,X_2,X_3,X_4) = $0.4/b,t,y,i+0.6/a.s.x.i+0.9/b,s,y,i+1/b,s,y,j+0.6/a,t,y,j+0.2/c,s,y,i$

(i) Compute the projections $R_{1.24}$, $R_{1..3}$, R_4 .

(ii)Compute cylindric extensions [$R_{1.24}$ ↑{X_3}],[$R_{1,.3}$ ↑{X_1,X_2,}],[R_4 ↑{X_1,X_2,X_3,}].5.

5. Consider the matrices

$$M_1 = \begin{pmatrix} 1 & 0 & 0{,}7 \\ 0.3 & 0.2 & 0 \\ 0 & 0.5 & 1 \end{pmatrix}; \quad M_2 = \begin{pmatrix} 0.6 & 00.6 & 0 \\ 0 & 0.6 & 1 \\ 0 & 0.1 & 0 \end{pmatrix}, \quad M_3 = \begin{pmatrix} 1 & 0 & 0{,}7 \\ 0 & 1 & 0 \\ 0.7 & 0 & 1 \end{pmatrix}$$

which representsa fuzzy tenary relation. Compute

(i) all two dimensional and one dimensional projections

(ii) cylindrical extension and cylindrical closures of the two dimensional and one dimensional projections.

Course Outcome (CO3):

1. The fuzzy binary relation R is defined on sets X={1,2,3..,100}. And Y ={ 50,51,…,100} and represents the relation "x is smaller than y. It is defined by the membership function

$$R(x,y) = \begin{cases} 1 - \frac{x}{y}; x \le y \\ 0; otherwise \end{cases}$$ where x € X and y € Y..

(i)What is the domain of R. (ii) What is the range and height of R. (iii) Calculate R^{-1}.

2 Let the relations be defined by the matrices

$$M_3 = \begin{pmatrix} 1 & 0 & 0{,}7 \\ 0 & 1 & 0 \\ 0.7 & 0 & 1 \end{pmatrix}, M_{12} = \begin{pmatrix} 1 & 0 & 0.8 & 0 & 0.6 & 0.8 & 0 \\ 0 & 1 & 0 & 0.6 & 0 & 0.5 & 0 \\ 0.8 & 0 & 1 & 0.8 & 0 & 0 & 0 \\ 0 & 0.6 & 0.8 & 1 & 0 & 0 & 0.8 \\ 0.6 & 0 & 0 & 0 & 1 & 0.6 & 0 \\ 0.8 & 0.5 & 0 & 0 & 0.6 & 1 & 0 \\ 0 & 0 & 0 & 0.8 & 0 & 0 & 1 \end{pmatrix}.$$

Draw simple diagrams of the relations and compute all complete alpha covers of the relations.

3. Consider the fuzzy matrix $R_1 = \begin{pmatrix} 1 & 0.8 & 0 & 0.1 & 0.2 \\ 0.8 & 1 & 0.4 & 0 & 0.9 \\ 0 & 0.4 & 1 & 0 & 0 \\ 0.1 & 0 & 0 & 1 & 0.5 \\ 0.2 & 0.9 & 0 & 0.5 & 1 \end{pmatrix}$.Experiment how many compositions are required to make the given tolerance relation into fuzzy equivalence relation.

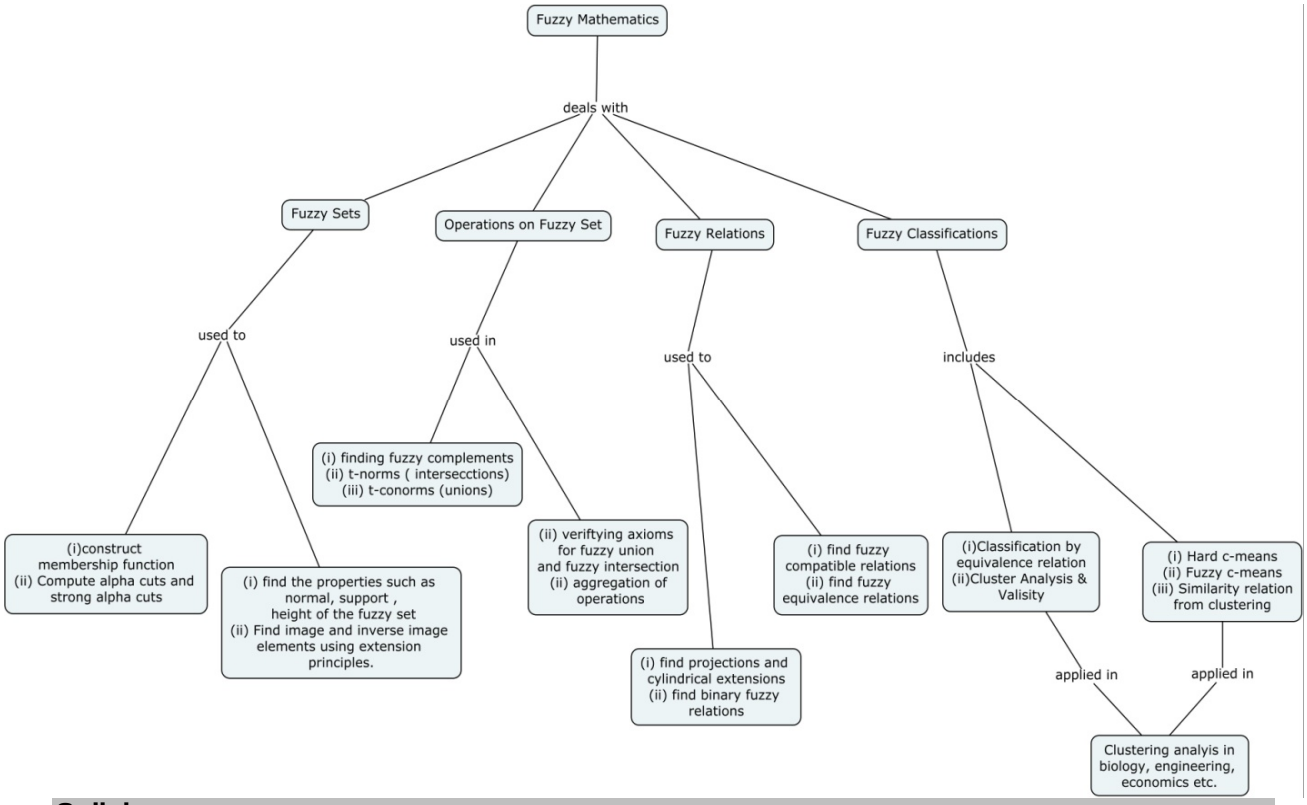
Course Outcome (CO4):

1. Produce algorithmic steps for K-Means clustering.
2. Produce algorithmic steps for Fuzzy c-Means clustering
3. Produce comparative analysis of Hard c-Means and Fuzzy c-Means Algorithms
4. The biochemical department of a prominent university is conduction research in bone structure. One study involves developing a relationship between the wrist joint angle and the sarcomere length . One study involves developing a relationship between the wrist joint angle and the sarcomere length in the lowest arm. In this study the following data were obtained.

Wrist Joint Angle (deg)	-75	-50	-25	0	25
Sarcomere Length (µm)	3	3.25	3.5	2.75	3

(a) Classify these data, into one cycle , into two classes using the hard c-means method.
(b) Classify these data into two classes using the fuzzy c-means method; use m'=2 and €=0.01 and conduct two cycles.
(c) Calculate the classification metric.
(d) Compute the similarity relation for the U-partition from part (b).

Concept Map



Syllabus

Fuzzy Sets: Basic Types – Basic Concepts – α-Cuts – Additional Properties of α-Cuts – Representations of Fuzzy Sets - Extension principle for Fuzzy Sets, Basic Concepts of Fuzzy Numbers. **Operations on Fuzzy Sets:** Types of Operations – Fuzzy Complements – t-Norms (Fuzzy Intersections) – t-Co-norms (Fuzzy Unions) – Combinations of Operations.
Fuzzy Relations: Crisp Versus Fuzzy Relations – Projections and Cylindrical Extensions – Binary Fuzzy Relations – Fuzzy Equivalence Relations – Fuzzy Compatibility Relations.
Fuzzy Classification : Classification by Fuzzy Equivalence relations - Cluster Analysis - Cluster Validity – C-means Clustering - Hard C-means - Fuzzy C-means - Hardening the Fuzzy C-Partitions – Similarity Relations from Clustering.

Text Books

1. George J.Klir and Bo Yuan, "Fuzzy Sets and Fuzzy Logic", Prentice Hall of India, New Delhi, 2004.
2. Timothy J.Ross, "Fuzzy Logic with Engineering Applications", second edition, John Wiley & Sons Pvt. Ltd, 2005.

Reference Books

1. H.J. Zimmermann, "Fuzzy Set Theory and its Applications", Allied Publishers Limited, New Delhi, 1991.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1	**Fuzzy Sets**	
1.1	Basic Types & Basic Concepts	2
1.2	α-cuts	1
1.3	Additional Properties of α- Cuts	1
1.4	Representations of Fuzzy Sets	1
1.5	Extension Principle for Fuzzy Sets	2
1.6	Basic Concepts of Fuzzy Numbers	2
2	**Operations on Fuzzy Sets**	
2.1	Types of Operations	1
2.2	Fuzzy Complements	1
2.3	t-Norms (Fuzzy Intersections)	2
2.4	t-Co-norms (Fuzzy Unions)	2
2.5	Combinations of Operations	2
3	**Fuzzy Relations**	
3.1	Crisp Versus Fuzzy Relations	2
3.2	Projections and Cylindrical Extensions	1
3.3	Binary Fuzzy Relations	2
3.4	Fuzzy Compatibility Relations	2
3.5	Fuzzy Equivalence Relations	2
4	**Fuzzy Classification**	
4.1	Classification by Fuzzy Equivalence Relations	2
4.2	Cluster Analysis - Cluster Validity	1
4.3	C-means Clustering	2
4.4	Hard C-Means , Fuzzy C-Means-	3
4.5	Hardening the Fuzzy C-Partitions	1
4.6	Similarity Relations from Clustering.	1
	Total hours	**36**

Course Designer:

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Dr. M.Kameswari mkmat@tce.edu

14MAFC0 NUMBER THEORY

Category	L	T	P	Credit
FE	3	0	0	3

Preamble

Number theory is a fast and fascinating field of mathematics, sometimes called "higher arithmetic" consisting of the study of the properties of whole numbers. The Theory of Numbers has always occupied a unique position in the world of Mathematics. Because of the basic nature of its problems, number theory has a fascinating appeal for the leading mathematicians as well as for thousands of amateurs. There is no denying of the fact that the elementary theory of numbers should be considered as one of the best subjects for early Mathematical instructions. It requires no long preliminary training; the content is well defined and familiar and above all, other than any other part of mathematics – the methods of inquiry adhere very much to the scientific approach.

Prerequisite

NIl

Course Outcomes

On the successful completion of the course, students will be able to

CO1:	Identify the greatest common divisor and least common multiple using Euclidean algorithm.	Apply
CO2	Identify the solutions for the congruence equation for degree 1 and also higher degree with prime power moduli.	Apply
CO3:	Solve the quadratic residues for each prime number	Apply
CO4:	Explain the properties of arithmetic functions such as Euler's function, Mobius function and its inverse functions.	Understand
CO5:	Solve and identify the positive integral solutions for some Diophantine equations.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO3.	**S**	**M**	**L**	**L**					**M**			**L**
CO4.	**S**	**M**	**L**	**L**					**M**			**L**
CO3.	**S**	**M**	**L**	**L**					**M**			**L**
CO4.	**S**	**M**	**L**	**M**					**M**			**L**
CO5.	**S**	**M**	**L**	**L**					**M**			**L**

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	10	10	10	10
Understand	30	30	30	30
Apply	60	60	60	60
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Define prime number.
2. State Euclids algorithm.
3. Show that the set of all prime numbers are infinite.

Course Outcome 2 (CO2):

1. Predict the solution for the congruence equation $x^2 + x + 7 \equiv 0 (\mathrm{mod} 15)$.
2. Find all solutions of the congruence $20x \equiv 4 \bmod(30)$.
3. Solve $x^5 + x^4 + 1 \equiv 0 \bmod 3^4$.

Course Outcome 3 (CO3):

1. Estimate all primes p such that $\left(\frac{10}{p}\right) = 1$.
2. State quadratic reciprocity law.
3. State and prove the Gaussian reciprocity law.

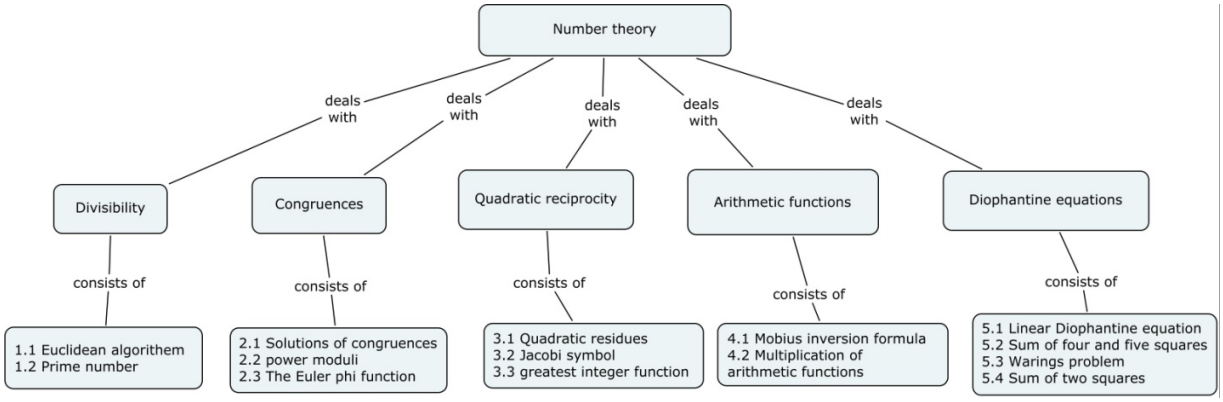
Course Outcome 4 (CO4):

1. Define Mobius function.
2. Predict a positive integer n such that $\mu(n) + \mu(n+1) + \mu(n+2) = 3$
3. Show that the set of all arithmetic functions f with $f(1) \neq 0$ forms a group under Dirichlet multiplication.

Course Outcome 5 (CO5):

1. Estimate all solutions in positive integers the Diophantine equation $5x + 3y = 52$.
2. Find all primitive solutions of $x^2 + y^2 = z^2$ having $0 < z < 30$.
3. Prove that $101x + 37y = 3819$ has a positive solution in integers

Concept Map



Syllabus

Divisibility: Introduction to Divisibility – Primes. **Congruences :** Congruences – Solutions of congruences – Chinese remainder theorem – Congruence's of degree one – The function $\varphi(n)$ - Congruence of higher degree two – Prime modulus – power residues. **Quadratic reciprocity:** Quadratic residues – Quadratic reciprocity – The Jacobi symbol. **Some Functions of Number theory:** Greatest integer function – Arithmetic functions – The Mobius inversion formula – The multiplication of arithmetic functions. **Diaphantine equations:** The equation $ax + by = c$ - Positive solutions – Other linear equations – The equation $x^2 + y^2 = z^2$ - The equation $x^4 + y^4 = z^2$ - Sums of Four and Five squares – Waring's Problem – Sum of fourth powers – Sum of Two squares.

Text Book

1. Ivan niven and H. S. Zuckerman "An introduction to the theory of numbers'' fifth edition, Wiley Eastern limited, 1991.
2. David M. Burton "Elementary number theory", sixth edition, TATA Mcgraw hill Education, 2005.

Reference Books

1. T.M.Apostol "Introduction to Analytic number theory" fifth edition, Springer international student edition, Narosa publishing house, 1988.
2. K. C. Chowdhury "A first course in number theory" first edition, Asian books private limited, 2007.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
	Divisibility	
1.1	Introduction to Divisibility	2
1.2	Primes	2
	Congruences	
2.1	Solutions of congruences	2
2.2	Chinese remainder theorem, Congruences of degree 1	2
2.3	The function $\varphi(n)$	2
2.4	Congruences of higher degree with prime power moduli	2

Module No.	Topic	No. of Lectures
	Quadratic reciprocity	
3.1	Quadratic residues	2
3.2	Quadratic reciprocity	2
3.3	The Jacobi symbol	2
3.4	Greatest integer function	2
	Arithmetic functions	
4.1	The Mobius inversion formula	2
4.2	The multiplication of arithmetic functions	2
	Diaphantine equations	
5.1	The equations $ax + by = c$	2
5.2	Positive solutions and Other linear equations	2
5.3	The equation $x^2 + y^2 = z^2$	2
5.4	The equation $x^4 + y^4 = z^2$	2
5.5	Sums of four and five squares	1
5.6	Warings problem and Sum of fourth powers	1
5.7	Sum of two squares	2
	Total hours	**36**

Course Designers:

Dr. R. Suresh suresh080183@tce.edu

		Category	L	T	P	Credit
14PHFA0	**SMART MATERIALS FOR ENGINEERS**	FE	3	0	0	3

Preamble

Smart materials find widespread applications in modern day actuators and sensors, coupled with multifunctional materials and functionally graded materials. By using smart materials, one can endow structures with built-in responses to innumerable contingencies. In their various forms, these materials can perform as actuators, which can adapt to their environments by changing characteristics such as shape and stiffness, or as sensors, which provide the actuators with information about structural and environmental changes. This course explains the various classes of smart materials and their applications pertaining to different engineering disciplines.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course, students will be able to

CO 1.	Understand the basic mechanisms of Smart Materials	Apply
CO 2.	Select the Smart Materials for Magneto-Thermo-Mechanical Applications	Apply
CO3.	Investigate the parameters used in strain measurements	Apply
CO 4.	Analyse the Smart Materials based micro sensors and micro actuators	Apply
CO 5.	Review the newly discovered smart materials	Analyse

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12
CO1	**S**	**L**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO2	**S**	**M**	**S**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO3	**M**	**M**	**S**	**S**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO4	**M**	**M**	**S**	**S**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**S**
CO5	**M**	**L**	**L**	**L**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**S**

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	30	30	30	30
Apply	50	50	40	40
Analyse	-	-	10	10
Evaluate	-	-	-	-
Create	-	-	-	-

Course Outcome 1 (CO1):

1. What are smart materials? Give some examples
2. Group the emergin Biomimetics.
3. What is Martensite transformation?
4. Distinguish between one-way and two-way shape memory effects.
5. Outline the importance of Villari effect and Joule effect.

Course Outcome 2 (CO2):

1. Illustrate the microscopic and macroscopic perspectives of Martensite and Austenite transformations
2. Outline the conditions to achieve shape memory effect.
3. Summarise the different actuation principles with suitable examples.
4. Research the mechanism behind the damping by smart structures.
5. Write in detail some size dependent macroscopic properties with examples.

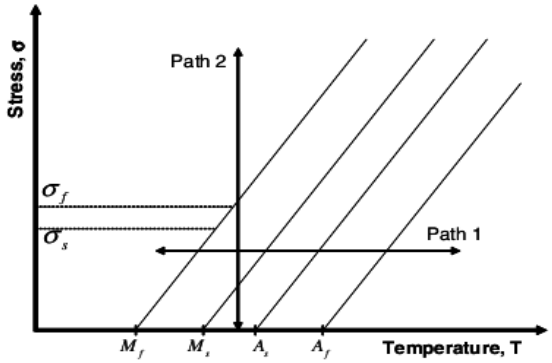
Course Outcome 3 (CO3):

1. An industrial process requires a small pressure vessel for storing hot gas.The pressure and the temperature inside the vessel cannot exceed 300 MPa and 80◦ C, respectively. Suggest two concepts that implement SMAs in the design of a safety device for the pressure vessel. Suggest an SMA for this application making suitable arguments.
2. Exhibit the large magnetic field induced strain in ferromagnetic shape memory alloys and saturation magnetization in magnetostrictive materials
3. Describe the applications of shape memory ceramics and polymers.

Course Outcome 4 (CO4):

1. Demonstrate the force generation of a piezo actuator with nominal displacement of 30 µm and stiffness of 200 N/µm? The piezo actuator can produce a maximum force of 30 µm x 200 N/µm = 6000 N. When force generation is maximum, displacement is zero and vice versa.

2. Compute and Plot a schematic of the stress-strain response of an SMA specimen when it is thermomechanically loaded along loading paths 1 and 2, shown in the phase diagram. Note that the initial state of the material is austenitic for loading in path 2



Course Outcome 5 (CO5):

1. A particular application requires multiple cyclic actuation where the actuator needs to expand at high temperature and contract as the temper-ature decreases. The device assembly or the conditions of operation do not exert any stress on the actuator. How could one use an SMA for such an application?

2. Consider the following statements.
   A. PZT is a smart materials
   B. PZT produces heat when a voltage is applied to it.
   a. A only true
   b. B only true
   c. Both A and B are true
   d. Both A and B are false

3. Consider the following statements
   A. Ferromagnetic shape memory effect is due to twin boundary motion
   B. Shape memory effect in Nitinol is due to martensite transformation
   a. A only true
   b. B only true
   c. Both A and B are true
   d. Both A and B are false

4. Consider the following actuation principles and corresponding materials and match them.

Actuation principle		**Smart Material**
a. Martensite transformation	-	Lead Zirconate Titanate
b. Twin boundary motion		Terfenol-D
c. Piezoelectric effect	-	Ni_2MnGa
d. Magnetostriction	-	Nitinol

Syllabus

Overview of Advances in Materials Science and its Applications in Engineering: Ancient Materials - Conventional Materials - Advanced Materials- Smart/Emerging Materials - Smart Phone/iPhone- Pendrive/External Hard Disk - Spectacles - Mixer Grinders- Refrigerators - Antenna - Motors. **Shape Memory Alloys (SMA):** History of SMA - Microscopic and Macroscopic Perspectives of Martensite/Austenite Transformations – Superelasticity – One-way and Two-way Shape Memory Effect –Aerospace, Medical and Transport Applications - Problems **Rheological Fluids:** Electro Rheological Fluid (ERF) and Magneto Rheological Fluid (MRF) – ERF Based Mount – MRF Based Mount – Damping Concept Selection – Vibration of Simple Structures – Methods for Laminated and Discrete Type Smart Structures- Problems. **Sensor and Actuator Materials Technology:** Sensing and Actuation Principles - Piezoelectricity – Piezoelectric Coefficients–Specifications and Terminologies – Piezoelectric Strain Measurement - Villari Effect – Matteuci Effect – Nagoka- Honda Effect – Joule Effect – Wiedemann Effect - Structural Health Monitoring- Microvalves – Linear Actuators- Problems.**Advances in Smart Materials:** Ferromagnetic SMA - Field Induced Strain in FSMA - Magnetostrictive Materials -Smart Polymer Composite Materials -Self-Assembled Nanostructures -Energy Harvesting Materials - Intelligent Materials –Problems.

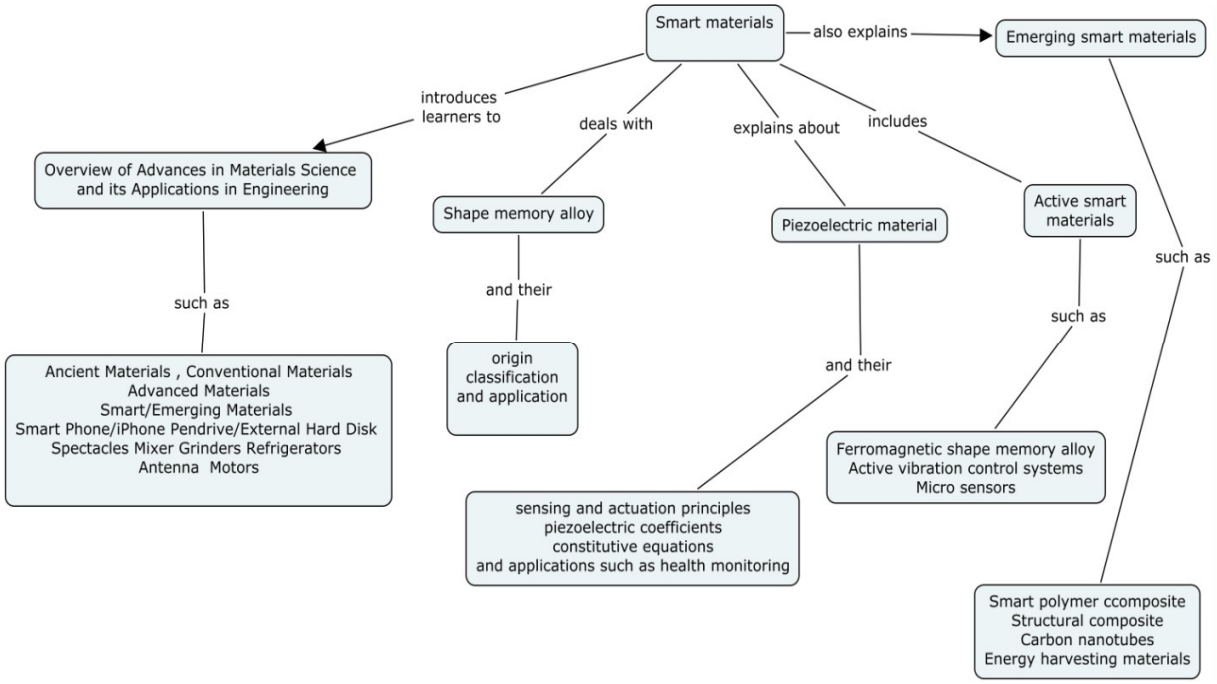
Text Books:

1. M.V. Gandhi and B.S. Thompson, Smart Materials and Structures, Chapman & Hall UK, 1992
2. V.K. Wadhawan, Smart Structures, Oxford University Press, UK, 2007
3. Mel Schwartz, Smart Materials, CRC Press New York, 2009
4. Christian Lexcellent, Shape Memory Alloys Handbook, John Wiley & Sons, USA, 2013
5. V.K. Varadhan, K.J.Vinoy and S. Gopalakrishanan, Smart Materials and MEMS, John Wiley & Sons, UK, 2006

Reference Books:

1. William D. Callister**,** Materials Science and Engineering: An Introduction, Wiley, 2004
2. M. Kohl, Shape Memory Microactuators, Springer, New York, 2004
3. Dimitris C. Lagoudas, Shape Memory Alloys, Springer, New York, 2008
4. Micky Rakotondrabe, Smart Materials- Based Actuators at Micro/Nano-Scale, Springer Science + Business Media, New York, 2013
5. Jan Fischer-Wolfarth and Gereon Meyer, Advanced Microsystems for Automotive Applications, Springer International Publishing, Switzerland, 2013

Concept Map



Course Contents and Lecture Schedule

S.No	Topic	No. of Lectures
1	**Introduction and Overview**	
1.1	Introduction to Materials Science and its Impact in Engineering	2
1.2	Functional Materials and Advanced Materials	1
1.3	Overview of the Applications of Smart Materials in Engineering	1
2	**Shape Memory Alloys (SMA)**	
2.1	History of Shape Memory Alloys	1
2.2	Microscopic and Macroscopic Perspectives of Martensite/Austenite Transformations	2
2.3	Superelasticity- One-way and Two-way Shape Memory Effect	2
2.4	Shape Memory Ceramics and Polymers	1
2.5	Applications and Problems in SMA	2
3	**Rheological Fluids**	
3.1	Electro Rheological (ER) and Magneto Rheological (MR) Fluids	2
3.2	ERF Based Mount – MRF Based Mount	2
3.3	Damping Concept Selection	2
3.4	Vibration of Simple Structures	1
3.5	Methods for Laminated and Discrete Type Smart Structures-Problems	1
4	**Sensor and Actuator Materials Technology**	
4.1	Overview – Specifications and Terminology for Sensors	2
4.2	Piezoelectric Coefficients and Strain Measurement	2

4.3	Villari Effect – Matteuci Effect – Nagoka- Honda Effect – Joule Effect – Wiedemann Effect	2
4.4	Actuation and Sensing Principles and Structural Health Monitoring	2
4.5	Applications and Problems	2
5	**Advances in Smart Materials**	
5.1	Ferromagnetic SMA – Field Induced Strain in FSMA	2
5.2	Smart Polymer Composite Materials	1
5.3	Self-Assembled Nanostructures - Energy Harvesting Materials	1
5.4	Intelligent Materials – Magnetostrictive Materials- Problems	2
Total hours		36

Course Designer:

Dr. M. Mahendran . manickam-mahendran@tce.edu

14PHFB0 THINFILM TECHNOLOGY

Category	L	T	P	Credit
FE	3	0	0	3

Preamble

Thin film Technology has attracted much attention in the recent years due to its potential application in the field of micro and nano scale device fabrication. This course imparts knowledge on the various methods of thin film preparation and characterization techniques, application of thin films in the fabrication of integrated circuit components, photovoltaic devices, integrated gas sensors, thermal barrier and self healing coating for heat engines and turbines and multilayer coatings for optical devices.

Prerequisite

Basic course : - NIL -

Course Outcomes

On the successful completion of the course, students will be able to

CO 1.	Explain various types of vacuum production and measurement techniques and theory of evaporation.	Understand
CO 2.	Demonstrate various types of thinfilm deposition techniques.	Apply
CO 3.	Calculate the optical constants and demonstrate multilayer coatings for optical device application.	Apply
CO 4.	Compute sheet resistance, resistivity, carrier concentration and mobility of thinfilms.	Apply
CO 5.	Demonstrate the application of thinfilm technology to develop integrated circuit components, PV cells, photoconductors, sensors and thermal barrier and self healing coatings for heat engine and turbine applications.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	L	-	-	-	-	-	-	-	-	M	-
CO2	M	M	M	M	-	-	-	-	-	-	M	-
CO3	M	M	-	-	-	-	-	-	-	-	M	-
CO4	M	L	M	M	-	-	-	-	-	-	M	-
CO5	M	L	M	M	-	M	-	-	-	-	M	-

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	30	30	30	30
Understand	40	40	40	40
Apply	30	30	30	30
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Cite the difference between thick film and thin film.
2. Summarize the construction, working, merits and limitations of a diffusion pump.
3. Discuss in detail the cosine law of emission and report its significance.
4. Describe the construction and working of a penning gauge.

Course Outcome 2 (CO2):

1. List various types of evaporation process and discuss its advantages.
2. Demonstrate the RF sputtering technique and list its advantages over DC sputtering method.
3. Illustrate the spin coating method to deposit Zirconia thinfilms on SS-304L grade substrate.
4. Demonstrate the spray pyrolysis method and sequence its merits and limitations.

Course Outcome 3 (CO3):

1. Apply the transmittance and reflectance method to determine the optical constants of transparent thinfilms.
2. Demonstrate suitable multilayer coatings to enhance the transmittance of glass for optical device applications.
3. Sequence the procedure to calculate the band gap energy of conducting thinfims using transmission data.
4. Illustrate the methodology and materials used in the H4 coatings and list its merits.

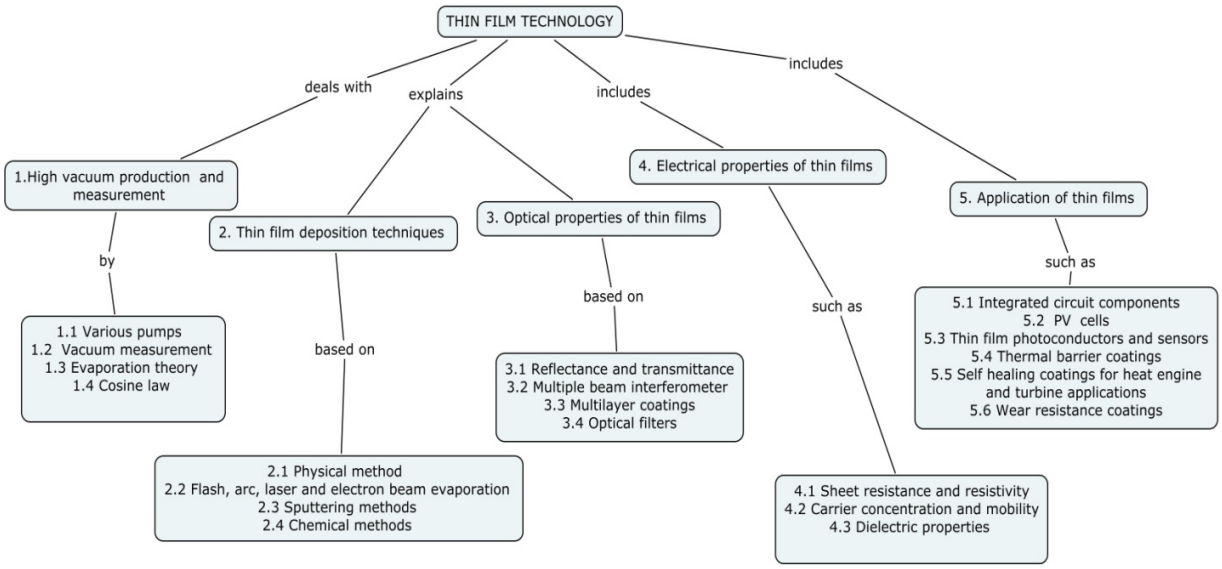
Course Outcome 4 (CO4):

1. Demonstrate the four probe method to calculate the sheet resistance and resitivity of conducting thinfilms.
2. Illustrate the Hall experiment to calculate the carrier concentration and mobility of semiconducting thinfilms.
3. Demonstrate the direct measurement technique to calculate the sheet resistance and resistivity of a conducting thinfilm and discuss its limitations.
4. Sequence the experimental procedure to calculate the electron and hole density and nature of a semiconducting thinfilm.

Course Outcome 5 (CO5):

1. Illustrate the fabrication of thinfilm diode and list the material used in this process.
2. Demonstrate the development and testing of an integrated LPG gas sensor.
3. Summarize the fabrication and testing procedure of CdS/Cu_2S solar cell.
4. Demonstrate the thermal barrier coating procedure to improve the performance of a heat engine.

Concept Map



Syllabus

High vacuum production and measurement – Introduction to thin films - Mechanical pumps – Rotary pump - Diffusion pump – Turbo molecular pump – Vacuum measurement – Pirani gauge – Penning gauge - Evaporation theory - Free evaporation and effusion evaporation - Cosine law of emission. **Thinfilm deposition techniques** - Physical method - Vacuum evaporation - Study of thinfilm vacuum coating unit – Flash, arc, laser and electron beam evaporation - Sputtering method - Sputtering mechanism - DC sputtering – RF sputtering - Chemical methods - Spray pyrolysis – Dip coating - Spin coating. **Optical properties** - Introduction to optical properties - Reflection and transmission by a single layer film – Determination of optical constants by reflectance and transmittance method - Thickness measurement - Multiple beam interferometery – Weight gain method - – Multi layer coatings – Optical filters - Application to optical devices. **Electrical properties** – Sheet resistance – Direct measurement – Four probe method to determine film resistivity - Hall effect – Determination of carrier concentration and mobility – Dielectric properties of metallic thinfilms – Break down mechanism in dielectric thinfilms. **Application of thinfilms** - Materials, design and fabrication of thinfilm resistor – Thinfilm capacitors – Thinfilm diodes – Thinfilm mask blanks for Integrated circuits and VLSI - High temperature sensors – Integrated Sensors for Gas Detection - Thinfilm solar cells – CdS/Cu_2S and $CdS/CuInSe_2$ Solar cells – Thinfilm Photo Conductors - Thermal barrier and self healing coating for turbines and heat engines - Wear resistance coating.

Text Books:

1. Zexian Cao - Editor, Thinfilm Growth: Physics, Materials Science and Applications, Woodhead Publishing, 1st Edition, New Delhi, 2011.
2. A. Goswami, Hand book of Thinfilm Technology, New Age International (P) Ltd., New Delhi, 1st Edition, 2006.

Reference Books:

1. K.Seshan, Handbook of Thin Film Deposition, ChemTech Publishing, 3rd Edition, Canada, 2012.
2. K.L. Chopra, Thinfilm Phenomena, McGraw Hill, New York 1990.

Course Contents and Lecture Schedule:

Module No	Topic	No of Lecture Hours
1.0	**High vacuum production and measurement**	
1.1	Introduction to thinfilms - Mechanical pumps – Rotary pump - Diffusion pump – Turbo molecular pump	3
1.2	Vacuum measurement – Pirani gauge – Penning gauge	2
1.3	Evaporation theory - Free evaporation and effusion evaporation - Cosine law of emission.	2
2.0	**Thinfilm deposition techniques**	
2.1	Physical method - Vacuum evaporation - Study of thinfilm vacuum coating unit - Flash, arc, laser and electron beam evaporation	3
2.2	Sputtering method - Sputtering mechanism - DC sputtering – RF sputtering	2
2.3	Chemical methods - Spray pyrolysis – Dip coating - Spin coating.	2
3.0	**Optical properties of thinfilms**	
3.1	Introduction to optical properties - Reflection and transmission by a single layer film	1
3.2	Determination of optical constants by reflectance and transmittance method	2
3.3	Thickness measurement - Multiple beam interferometery – Weight gain method	2
3.4	Multi layer coatings – Optical filters - Application to optical devices.	2
4.0	**Electrical properties of thinfilms**	
4.1	Sheet resistance – Direct measurement – Four probe method to determine film resistivity	2
4.2	Hall effect – Determination of carrier concentration and mobility	2
4.3	Dielectric properties of metallic thinfilms - Break down mechanism in dielectric thinfilms.	1
5.0	**Application of thinfilms - Materials, design and fabrication**	
5.1	Thinfilm resistor – Thinfilm capacitors – Thinfilm diodes	2
5.2	Thinfilm mask blanks for Integrated circuits and VLSI	1
5.3	High temperature sensors – Integrated Sensors for Gas Detection	2
5.4	Thinfilm solar cells – CdS/Cu_2S and $CdS/CuInSe_2$ Solar cells	2
5.5	Thinfilm Photo Conductors	1
5.6	Thermal barrier and self healing coating for turbines and heat engines – Wear resistance coating.	2
	Total	**36**

Course Designer :

1. Dr. N. Sankara Subramanian shankersathiya@yahoo.com

14PHFC0	NANOTECHNOLOGY	Category	L	T	P	Credit
		FE	3	0	0	3

Preamble

Nanotechnology is one of the emerging areas in the science and technology and is a multidisciplinary field. This paper deals with the materials at nanoscale. It focuses on the quantum concepts and unique properties of the nano materials. Some of the widely used nanofabrication techniques such as nanolithography, sol-gel method, CVD and characterization tools like SPM, HRTEM will be discussed. The paper gives the overview of the role of nano materials in consumer markets, electronics and nano computing applications.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course, students will be able to

Mapping with Programme Outcomes

CO1	understand the significance of materials dimensions	Remember
CO2	exposed to the quantum concepts of nanoscale Materials	Apply
CO3	gather knowledge on the unique properties of various nanomaterials	Understand
CO4	describe the working principle of SEM and TEM	Understand
CO5	get an exposure on the enhanced external field effect on the energy level structures of the smaller dimensional materials	Analyse
CO6	appreciate the role of nanotechnology in various fields of Science and Technology and its commercial importance	Analyse

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	L	-	-	-	-	-	-	-	-	L	-
CO2	M	M	L	M	-	-	-	-	-	-	L	-
CO3	M	M	-	-	-	-	-	-	-	-	M	-
CO4	M	L	M	M	-	-	-	-	-	-	M	-
CO5	M	L	-	M	-	-	-	-	-	-	L	-
CO6	M	L	M	M	-	M	-	-	-	-	M	-

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	30	30	30	30
Apply	50	50	40	30
Analyse	0	0	10	20
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Give the paradigm for nanoscale dimension
2. What are bottom up and top down process?
3. Draw a schematic sketch of fullerene, bucky ball, and carbon nanotubes.

Course Outcome 2 (CO2):

1. The energy gap (Eg) in Zinc oxide (ZnO) is 3.2 eV.
    a. Is this material transparent to visible radiation?
    b. Do you expect this material to be a conductor at room temperature?
2. A microscope using photons is employed to locate an electron in an atom within a distance of 0.2 A^o. What is the uncertainty in the velocity of the electron located in this way?
3. A cubic quantum dot (QD) of GaAs has a =7.0 nm. Calculate the lowest three energy levels. Calculate the same if the dimensions of the QD are a=10 nm, b=8 nm and c=12 nm and $m^* = 0.067m_o$.

Course Outcome 3 (CO3):

1. Define supra molecules with examples.
2. Explore the technical significance of nanotubes and dendrimers
3. Write the merits of nano diodes and nano transistor

Course Outcome 4 (CO4):

1. Explain the working principle of TEM and HRTEM
2. Explain the confinement effect and its effect on the energy levels of low dimensional systems.
3. Describe the construction and working of SEM

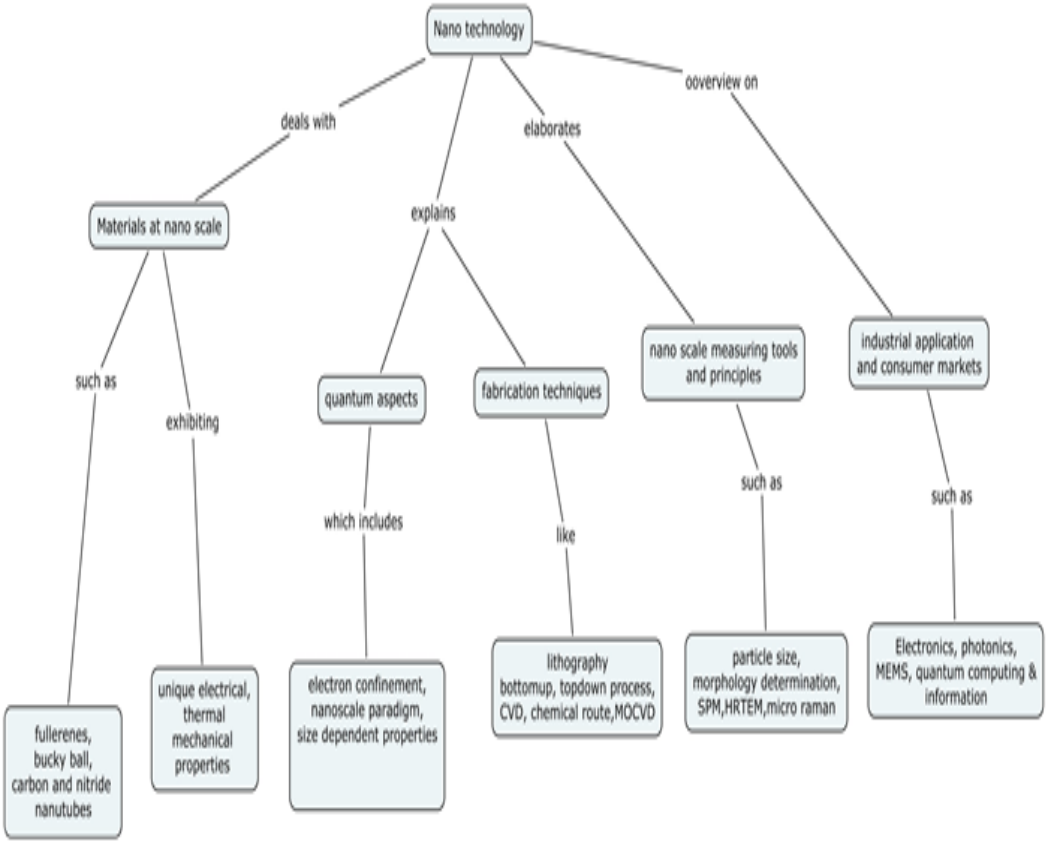
Course Outcome 5 (CO5):

1. Discuss about the quantum concepts relevant for nano systems
2. Briefly explain the chemical route synthesis of nano materials with the suitable diagram discuss the working of SPM and explain how the particle size and morphology can be determined?

Course Outcome 6 (CO6):

1. Compare the bulk level and nano sensors.
2. Explore the major advantages of nanomaterials for medical field.
3. Analyse the advantages of nanotechnology for society.

Concept Map



Syllabus

I**ntroduction to the discipline of Nanotechnology** – nanoscale dimension and paradigm, definitions- Moore's law, principles and quantum aspects, chemistry fundamentals for Nanotechnology, size dependent properties.**Nano fabrication techniques** – Nano lithography – Bottom up and top down process – Nanomaterial synthesis chemical route, sol-gel methods, Chemical vapor deposition (CVD)-Metal Organic chemical vapor deposition, ZnO and TiO2 nano materials preparation. **Characterization methods** –atomic structures, particle size determination, surface structure – Scanning Probe Microscope-High Resolution Transmission Electron Microscope (HRTEM) principles and working mechanism, Micro Raman spectroscopy, Magnetic Resonance –principles. **Emerging Nanostructure materials** - Fullerenes, Bucky ball, carbon nanotubes, single walled nanotubes, multi walled nanotubes – nitride nanotubes – organic molecules and supra molecular chemistry – polymer chemistry – Thin film deposition process- CdSe , ZnO -– plasma deposition – surface modifications – electrical, mechanical and thermal properties, nano-smart materials. **Overview of industry applications** – nano materials in consumer markets, electronics, photonics, MEMS, nano-bio applications – Quantum computing and informatics. Nanomaterials for device applications – nano diode, nano electrode, nano transistor. nano smart composites. nano for society.

Text Books:

1. M.Ratner and D.Ratner, "Nanotechnology" A gentle introduction to the next big idea. Pearson Education, Inc. 2003
2. V.K.Varadan, A.Sivathanu Pillai, D.Mukherji, M.Dwivedi and L.Chen Nanoscience and Nanotechnology in Engineering,World Scientific Publishing Co Pvt ltd, Singapore 2010
3. Charles P.Poole Jr. and Frank J.Owens, "Introduction to Nanotechnology: John Wiley & sons (Asia) Pvt.Ltd., Singapore, 2006

Reference Books:

1. Michael Wilson, Kamali Kannangara, G.Smith, M.Simmons and B.Raguse, "Nanotechnology – Basic Science and Emerging Technologies", chapman & Hall/CRC, Sydney, 2002.
2. Z.Tang and P.Sheng (Editors) Nanoscale Phenomena-Basic Science to Device Applications, Springer2008.

Course Contents and Lecture Schedule:

Module No	Topic	No of Lecture Hours
1.0	**Introduction to Nanotechnology**	
1.1	Nano science. Nanostructures , nano materials Definition and examples	2
1.2	Low Dimensional systems, Nanoscale dimension, paradigm, explanations	2
1.3	Moore's law I and II ,definitions, Interpretations, commercial significance	1
1.4	Fundamental principles, Quantum aspects, Size dependent properties	2
2.0	**Nano fabrication techniques**	
2.1	Nano lithography, bottom up and top down process, specific features of the methods	2
2.2	Synthesis of nano materials-chemical route, sol-gel methods	1
2.3	Advance synthesis methods-CVD,MOCVD principle and merits	2
2.4	Sample preparation-ZnO and TiO_2	2
3.0	**Characterization methods**	
3.1	Particle size and Morphology determination, modification techniques	1
3.2	Scanning probe microscope, different types, HRTEM,- Principles, Working mechanism,	2
3.3	Spectroscopic methods-merits and demerits, Micro Raman spectroscopy	2
3.4	Magnetic resonance-types, principles, Nuclear magnetic resonance, electron spin resonance	2

4.0	**Emerging nanostructure materials**	
4.1	Fullerenes, Buckyball, nano tubes-carbon, nitride,, structures, unique properties	2
4.2	Supra molecular chemistry-dendrimer, self assembly, Polymers	2
4.3	Thin film deposition ,Plasma deposition process details surface modification techniques	2
4.4	Physical and Chemical properties of thin films, nano structure materials.	1
5.0	**Overview of industrial applications**	
5.1	Impact in consumer markets	1
5.2	Role of nano materials in electronics, Photonics, MEMS, nano-bio applications	3
5.3	Nanotechnology for Quantum computing and Informatics	2
5.4	Device applications-nano diode,nano electrode, nano transistor and nanosmart materials,Applications to society.	2
	Total hours	36

Course Designer Dr.V.Gayathri vgphy@tce.edu

14CHFA0	BIOLOGY FOR ENGINEERS	Category	L	T	P	Credit
		FE	3	0	0	3

Preamble

The objective of this course is to make the students to understand the basic concept of cells which bring forth the components building a cell and cellular process, basic structural and functional aspects of proteins DNA, RNA and stem cells. It is also impacts the knowledge on understanding the software tools for analyzing and interpreting biological data by combining computer science, statistics, mathematics and engineering concepts.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course, students will be able to

CO 1. Explain the nature of cell and its functions	Understand
CO 2. Illustrate the mechanism of oncogenesis	Analyze
CO 3. Identify the function and mechanism of DNA, RNA	Analyze
CO 4. Evaluate the structural components of Biological molecules	Analyze
CO 5. Enumerate the stem cell functions	Remember
CO 6. Comprising the biological data using basic science and Engineering Concepts and Select appropriate software tool for analysing biological data	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1.	-	M	-	-	-	S	-	-	-	M	S	-
CO2.	-	S	-	-	M	S	M	-	-	M	S	-
CO3	-	M	-	-	M	S	M	-	-	M	S	-
CO4	-	M	-	-	M	S	-	-	-	M	S	-
CO5.	-	M	-	-	M	S	-	-	-	M	S	-
CO6	S	S	S	S	M	S	-	-	-	M	S	-

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	40	30	30	30
Apply	40	40	40	40
Analyze	0	10	10	10
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Define structure of cell.
2. Differentiate cellular assemblies in single cell to multi cellular organism.
3. Recall cell senescence.

Course Outcome 2 (CO2):

1. Interpret the mechanism of cell growth in oncogenesis.
2. Illustrate Mitosis and Meiosis cell division.
3. Mention the defects of cell cycle breakdown.

Course Outcome 3 (CO3):

1. Outline the role buffers in biomolecules structures.
2. Analyze the structure difference in DNA and RNA
3. Compare the functions of m-RNA, tRNA, rRNA.

Course Outcome 4(CO4)

1. Examine the formation, breakdown and interconversion process of carbohydrates in living organism.
2. Discuss the four distinct aspects of a proteins structure.
3. Analyse the categories of lipids based on its building block.

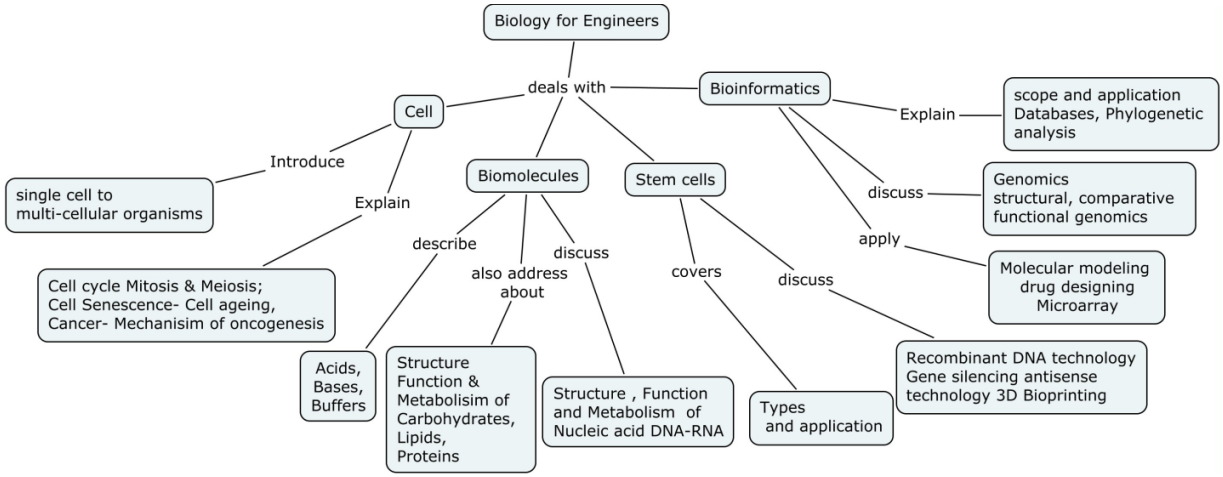
Course Outcome 5(CO5)

1. Recall Gene silencing and antisense technologies.
2. Define 3D Bioprinting.
3. Mention the technology involving in the recombinant of DNA.

Course Outcome 6(CO6)

1. Analyzecis-platin and trans-platinstructures for molecular docking studies.
2. Draw and analyse the relationships in phylogenetic tree.
3. Discuss the steps involving in phylogenetic analysis.

Concept Map



Syllabus

Cell: Structure - single cell to multi-cellular organisms; cell cycle – Mitosis & Meiosis; Cell Senescence- Cell ageing; Cancer- Mechanism of oncogenesis. **Chemistry of Biology**: Bonds, Inter molecular forces, Acids, Bases, Buffers; Biomolecules - Structure Function &Metabolism of Carbohydrates, Lipids, Proteins; Nucleic acids - DNA& RNA. **Stem cells** – Types and applications; Recombinant DNA technology; Gene silencing and antisense technology; 3D Bioprinting. **Bioinformatics**: Scope and applications, Databases, Phylogenetic analysis; Genomics – structural, comparative and functional genomics; Molecular modelling and drug designing; Gene expression - Microarray

Text Book

1. J. D. Watson, T. A. Baker, S. P. Bell, A. Gann, M. Levine and R. Losick, Molecular Biology of Gene, Seventh Edition. Pearson publication, U.S.A, 2014.
2. U. Satyanarayana and U. Chakrapani, Biochemistry, Book and Allied Pvt. Ltd., Kolkata.2009.

Reference Books

1. T.K. Attwood, D.J. Parry-Smith, Introduction to Bioinformatics. Pearson Education Singapore Ptc. Ltd, 2002.
2. W. Mount, Bioinformatics-sequence and genome analysis, II Edition, Cold Spring harbour Laboratory Press, New York, 2001.
3. J. Pevsner, Bioinformatics and Functional Genomics, III Edition, Wiley Dream tech India Ltd., New Delhi, 2003.

Course Contents and Lecture Schedule

	Topic	No. of Lectures
1.0	**Cell**	
1.1	Cell Structure - single cell to multi-cellular organisms	1
1.2	cell cycle – Mitosis & Meiosis	3
1.3	Cell Senescence- Cell ageing	2
1.4	Cancer- Mechanism of oncogenesis	2
2.0	**Chemistry of Biology**	
2.1	Bonds, Intermolecular forces, Acids, Bases, Buffers	2

	Topic	No. of Lectures
2.2	Biomolecules - Structure Function &Metabolism of Carbohydrates	2
2.3	Lipids, Proteins	3
2.4	Nucleic acids - DNA& RNA.	3
3.0	**Stem cells**	
3.1	Types & applications	2
3.2	Recombinant DNA technology	2
3.3	Gene silencing and antisense technology	2
3.4	3D Bioprinting	2
4.0	**Bioinformatics**	
4.1	Scope and applications	1
4.2	Databases	1
4.3	Phylogenetic analysis;	2
4.4	Genomics – structural, comparative and functional genomics	3
4.5	Molecular modelling and drug designing; Gene expression – Microarray	3
	Total number of Lectures	36

Course Designers:

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14CHFB0	CHEMISTRY OF ENGINEERING MATERIALS

Category	L	T	P	Credit
FE	3	0	0	3

Preamble

This course provides basic knowledge of structure and properties of materials such as lubricants, adhesives, explosive, propellants, ceramics, abrasives and sensor materials. It also bestows the role of chemistry in selection of materials in particular applications.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course, students will be able to

CO 1.	Identify suitable adhesives for engineering application	Analyze
CO2.	Demonstrate the various application of lubricants	Apply
CO 3.	Examine the essential characteristics of propellants	Analyze
CO 4.	Illustrate the role of ceramics / abrasive in fabrication of device	Apply
CO 5.	Compare the efficiency of sensors in field applications	Analyze
CO 6.	Summarize the sensing mechanism of various sensors	Understand

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**M**	**M**	**-**	**S**	**S**	**S**	**-**	**-**	**-**	**M**	**-**	**-**
CO2	**M**	**M**	**-**	**S**	**S**	**M**	**M**	**-**	**-**	**-**	**M**	**M**
CO3	**M**	**M**	**-**	**S**	**M**	**M**	**L**	**-**	**-**	**-**	**-**	**-**
CO4	**M**	**S**	**-**	**S**	**M**	**M**	**L**	**-**	**-**	**-**	**L**	**L**
CO5	**M**	**S**	**-**	**M**	**M**	**M**	**L**	**-**	**-**	**-**	**-**	**L**
CO6	**M**	**M**	**-**	**M**	**-**	**M**	**-**	**-**	**-**	**-**	**-**	**-**

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	40	30	30	30
Apply	40	40	40	40
Analyse	0	10	10	10
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Describe the bonding process of Adhesives.
2. Examine the physico-chemical factors influencing adhesive action.
3. Illustrate the process involved in strengthening of adhesives.

Course Outcome 2 (CO2):

1. Examine the function of electrical insulating oils in industrial application.
2. Demonstrate the influence of properties in lubrication action.
3. Explain the selection of lubricants for specific application.

Course Outcome 3 (CO3):

1. Compare properties between propellant and conventional fuel.
2. Describe the essential characteristics of rocket propellant.
3. Explain the way of storage and blasting explosives.

Course Outcome 4 (CO4):

1. Differentiate between crystalline and non crystalline ceramics.
2. Explain the methods involved in fabrication of ceramics.
3. Describe the action of abrasive in polishing materials

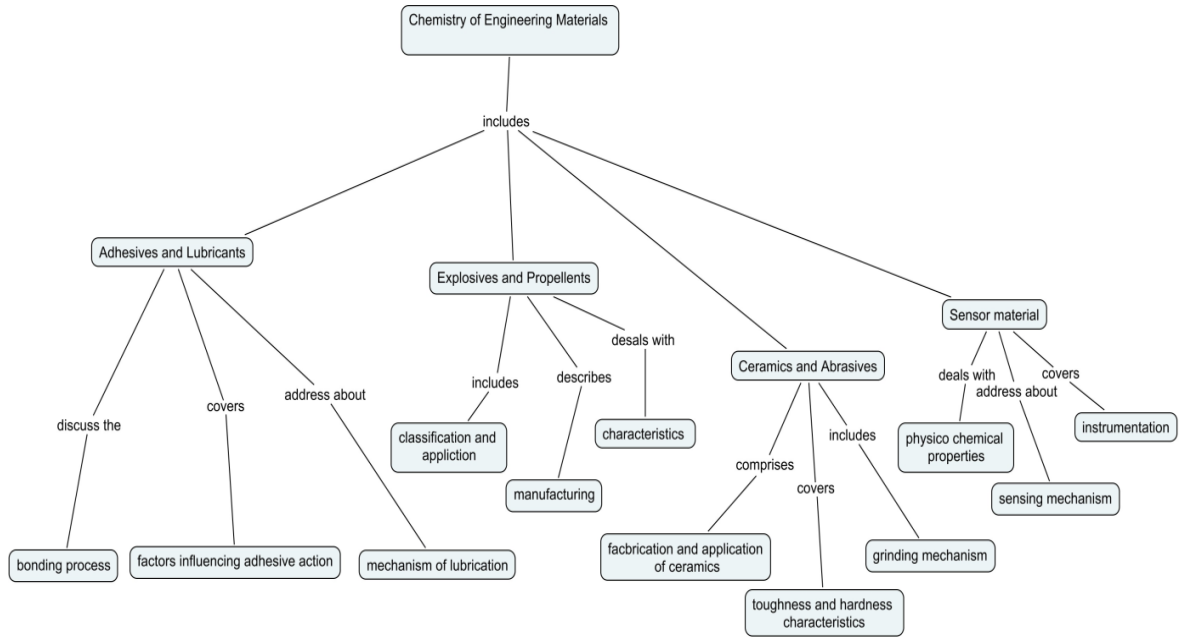
Course Outcome 5 (CO5):

1. Identify the suitable sensor for fluoride contamination in water.
2. Compare the sensor reliability in field applications..
3. Demonstrate the failure mechanism and evaluation study in field.

Course Outcome 6 (CO6):

1. Explain the principles of physical and chemical sensors.
2. Summarise classification of sensor.
3. Identify the suitable sensor for detection of cyanide contamination in water.

Concept Map



Syllabus

Adhesives and lubricants- Introduction to adhesives and lubricants-classification and bonding process of adhesives-chemical and physical factors influencing adhesive action -development of adhesive strength-classification -mechanism of lubrication-properties of lubricating oils and greases -cutting fluids, degradation of lubricating oils- electrical insulating oils -white oils**. Explosives and propellants** -Introduction and classification -characteristics, storage, blasting fuses – disarmament-constructive uses of explosives-preparation of important explosives-essential characteristics of rocket propellant. **Ceramics and Abrasives-** methods of fabrication of ceramics- types-and application of ceramics-classification and application of abrasives-abrasive grains and its characteristics-chemical reactions in grinding and chemical grinding aids**. Sensor material -**classification and physico –chemical properties of sensor-sensing mechanism-chemical and electrochemical sensors for environmental pollution monitoring-sensor-characterisation, calibration sensor reliability, aging test-failure mechanisms and their evaluation and stability study-Biosensor Instrumentation- transducers.

Text Book

1. C. Jain and Monika Jain, Textbook of Engineering Chemistry, DhanpatRai Publishing Co.2014
2. R.K. Rajput, Engineering Materials, S. Chand and Company Ltd., 2008.

Learning Resources

1. S.S. Dara and S.S. Umare, A Text book of engineering chemistry, S. Chand and Company Pvt Ltd., 2014.
2. T.C. Pearce, S.S. Schiffman, H.T. Nagle, J.W. Gardner,,Handbook of Machine Olfaction: Electronic Nose Technology. Wiley-VCH Verlag GmbH & Co, 2004

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1	**Adhesives and lubricants**	
1.1	Introduction to adhesives and lubricants	2
1.2	Classification and bonding process of adhesives	2
1.3	Chemical and physical factors influencing adhesive action	1
1.4	Development of adhesive strength	1
1.5	Classification - mechanism of lubrication	1
1.6	Properties of lubricating oils and greases	1
1.7	Cutting fluids, degradation of lubricating oils electrical insulating oils white oils	2
2	**Explosives and propellants**	
2.1	Introduction and Classification	2
2.2	Characteristics, storage, blasting fuses - Disarmament	2
2.3	Constructive uses of explosives	1
2.4	Preparation of important explosives	1
2.5	Essential characteristics of rocket propellant	2
3	**Ceramics and Abrasives**	
3.1	Methods of fabrication of ceramics	1
3.2	Types and application of ceramics	2
3.3	Classification and application of abrasives	2
3.4	Abrasive grains and its characteristics	1
3.5	Chemical reactions in grinding and chemical grinding aids	2
	Sensor material	
4.1	Classification and physico –chemical properties of sensor	2
4.2	Sensing mechanism	1
4.3	Chemical and electrochemical sensor for environmental pollution monitoring	2
4.4	Sensor characterization, calibration sensor reliability, aging test	2
4.5	Failure mechanisms and their evaluation and stability study	1
4.6	Biosensor Instrumentation- transducers	2
	Total	**36**

Course Designers:

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14CHFC0 BATTERY TECHNOLOGIES

Category	L	T	P	Credit
FE	3	0	0	3

Preamble

To impart fundamental knowledge on electrochemical energy storage systems considering the operation and design of various battery technologies. To enable the students to understand the requirement of batteries for automotive application combined with environment policy considerations.

Prerequisite

No Prerequisites

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Recognize the basic physical concepts of thermodynamics and kinetics involved in electrochemical reactions	Understand
CO2	Select the appropriate battery system with respect to application	Apply
CO3	Analyse the characterization methods of batteries and interpret concepts describing battery performance	Analyse
CO4	Describe the recent developments battery systems	Understand
CO5	Understand the requirements of battery systems for automotive applications and understand the modelling of battery systems	Understand
CO6	Discuss the Life Cycle Analysis according to cost and environmental aspects; material and energy consumption, reuse, recycling	Analyse

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	-	-	-	-	M	-	-	-	-	-	-
CO2	S	M	-	M	L	M	L	-	-	-	L	-
CO3	S	S	M	S	L	M	L	-	-	-	-	L
CO4	M	S	M	S	L	L	L	-	-	-	-	-
CO5	S	-	-	L	-	L	L	-	-	-	-	-
CO6	S	L	-	-	-	-	-	-	-	-	-	-

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	40	40	40	40
Apply	40	30	20	30
Analyse	-	10	20	10
Evaluate	-	-	-	-
Create	-	-	-	-

Sequence Level Assessment Questions

Course Outcome 1 (CO1):

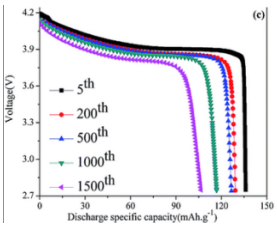
1. Explain the relation between chemical potential and free energy of charging and discharging reaction in a secondary battery?
2. Calculate standard cell potential for the following reaction?
   a. $Hg(s) / Hg_2Cl_2 / Cl^-(aq.) \,\mathrm{P}\, Zn^{2+}(aq.) / Zn(s)$
   b. E^0 (Zn^{2+}/Zn) = -0.76 V
   c. E^0 (Hg+/Hg) = +0.27 V
3. Exemplify how emf of an electrochemical cell can be measured experimentally?

Course Outcome 2 (CO2)

1. Present your views on usage of Lithium ion batteries for electric vehicle application?
2. How will you integrate super capacitor and battery hybrid systems for application in electronic gadgets?
3. Explain the issues and challenges facing development of lead acid batteries for automotive applications?

Course Outcome 3 (CO3)

1. Calculate the cell potential of a lead acid battery at the end of discharge (discharged at 0.3C rate and 298 K)? The Volume of H2SO4 at the start of discharge was 29% by weight (i.e activity coefficient = 0.842) and the volume of H2SO4 at the end of discharge is 21% by weight (i.e activity coefficient = 0.436) (Universal gas constant = 8.314 JK-1mol-1)
2. Calculate the charging capacity of a given Lead acid accumulator cell having cell potential 2.01 V and temperature coefficient of resistance 0.00037 V/K?
3. The discharge profile of Lithium ion battery with configuration of LiCoO2□LiPF6 (1:1 EC:DMC)□graphite after different cycles is presented in following figure. Present your views on the performance of the battery?



Course Outcome 4 (CO4)

1. Explain the charging and discharging mechanism of Lithium ion battery having LiCoO2 cathode and Graphite anode in Lithium ion conducting liquid electrolyte?
2. Explain in detail the usage of solid polymer electrolytes in Lithium ion batteries?

3. Explain the design and testing of Thin film micro Lithium ion Batteries?

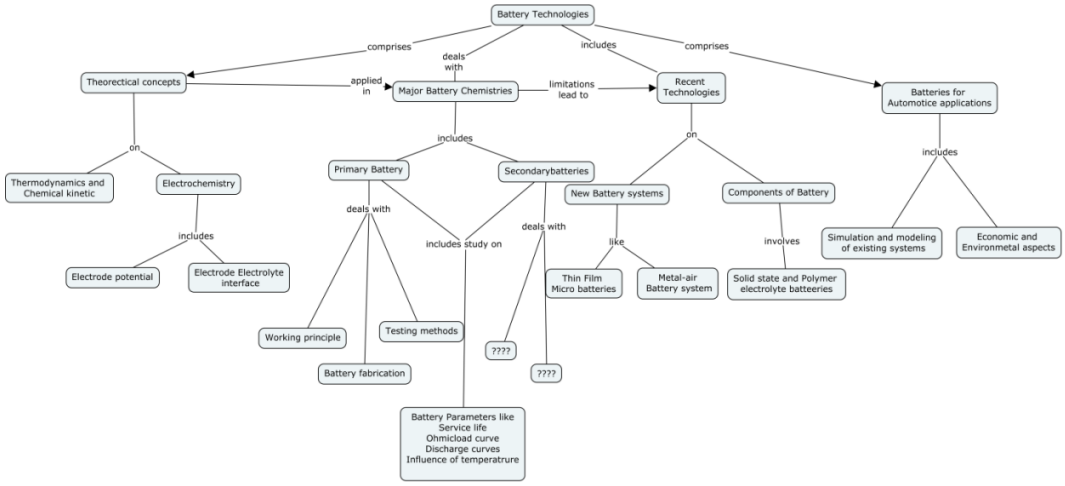
Course Outcome 5 (CO5)

1. Explain battery sizing factor?
2. Explain the global targets in improving the performance of Electric vehicle and Hybrid electric vehicle?
3. Describe the recycle pathway of spent lead acid batteries?

Course Outcome 6 (CO6)

1. Identify methods to recycle spent Lithium ion batteries?
2. How will you determine the shelf life and calendar life of a battery?
3. Organize the inputs needed to model open circuit potential of Lithium ion battery?

Concept Map



Syllabus

Introduction to Electrochemical energy storage: Introduction to battery technologies- Electromotive force- Reversible cells- Relation between electrical energy and energy content of a cell-Free energy changes and electromotive force in cell- Current challenges in Energy storage Technologies. **Major Battery Chemistries Development and testing:** Battery performance evaluation- Primary battery - Service time- Voltage data- Service life – ohmic load curve- Effect of operating temperature on service life. Secondary batteries- Discharge curves- Terminal voltages- Plateau voltage –Lead acid Batteries – Construction and application. **Recent Technologies:** Recent development of electrode materials in lithium ion batteries- Recent development of solid electrolytes and their application to solid state batteries-Polymer solid electrolytes for lithium ion conduction– Thin Film solid state Batteries: Fundamentals, Constriction and application – Super Capacitors: Fundamental, Construction and application. **Batteries for Automotives – Future prospects:** Degrees of vehicle electrification - Battery size vs. application -USABC and DOE targets for vehicular energy storage systems - Analysis and Simulation of batteries - Equivalent circuit and life modeling – Environmental concerns in battery production – recycling of batteries

Text Book

1. T.Minami, M.Tatsumisago,M.Wakihara,C. Iwakura,S. Kohijiya, Solid state ionics for batteries, Springer Publication, 2009
2. Sandeep Dhameja, Electric Vehicle Battery Systems, Newnes publication, 2001.

Reference Books

1. Bard, Allen J., and Larry R. Faulkner. Electrochemical Methods: Fundamentals and Applications. 2nd ed.,Wiley– VCH, Verlag, GmbH, 2000.
2. Masataka Wakihara and Osamu Yamamoto, Lithium ion Batteries Fundamental and Performance,Wiley–VCH, Verlag GmbH, 1999.
3. Robert A.Huggins, Advanced Batteries – Materials science aspects,Springer, 2009.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1.0	**Introduction to Electrochemical energy storage**	
1.1	Introduction to battery technologies	2
1.2	Electromotive force- Reversiable cells-Reversiable electrodes	2
1.3	Relation between electrical energy and energy content of a cell-Free energy changes and electromotive force in cell	2
1.4	Current challenges in Energy storage Technologies	2
2.0	**Major Battery Chemistries**	
2.1	Battery performance evaluation	2
2.2	Primary battery Service time- Voltage data- Service life – ohmic load curve	2
2.3	Effect of operating temperature on service life – other chartacteristic curves	2
2.4	Secondary batteries- Discharge curves - Terminal voltages- Plateau voltage	2
2.5	Lead acid Batteries – Construction and application	2
3.0	**Recent Technologies**	
3.1	Recent development of electrode materials in lithium ion batteries	2
3.2	Recent development of solid electrolytes and their application to solid state batteries	2
3.3	Polymer solid electrolytes for lithium ion conduction	1
3.4	Construction and state of art of Thin Film Batteries	2
3.5	Super Capacitors: Fundamental, Construction and application	1
4.0	**Batteries for Automotives – Future prospect**	
4.1	Degrees of vehicle electrification	1
4.2	Battery size vs. application	1
4.3	USABC and DOE targets for vehicular energy storage systems	1
4.4	Analysis and Simulation of batteries - Equivalent circuit and life modeling	2
4.5	Environmental concenrn in battery production	3
4.6	Environmental concerns in recyclingof batteries	2
Total number of Lectures		36

Course Designers:

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