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Note : Remove “Table of Content” before including in CP Book
Each Course Plan shall be printed and made into a book with cover page
Blooms Level in all sections match with A.2, only if you plan to teach / learn at higher levels

15ME745: SMART MATERIALS & MEMS

A. COURSE INFORMATION

1. Course Overview

Degree:	BE	Program:	ME
Year / Semester :	4th /7th	Academic Year:	2018-19
Course Title:	SMART MATERIAL & MEMS	Course Code:	15ME745
Credit / L-T-P:	3/3-0-0	SEE Duration:	180 Minutes
Total Contact Hours:	52	SEE Marks:	80 Marks
CIA Marks:	20	Assignment	2 / Module
CoursePlan Author:	Dr. S V PRAKASH	Sign	Dt:
Checked By:		Sign	Dt:

2. Course Content

Module	Module Content	Teaching Hours	Module Concepts	Blooms Level
1	Introduction: Closed loop and Open loop Smart Structures. Applications of Smart structures, Piezoelectric properties. Inchworm Linear motor, Shape memory alloys, Shape memory effect-Application, Processing and characteristics. Shape Memory Alloys: Introduction, Phenomenology, Influence of stress on characteristic temperatures, Modelling of shape memory effect. Vibration control through shape memory alloys. Design considerations, multiplexing embedded NiTiNOL actuators.	10	Shape Memory Alloys	L2 understand
2	Electro rheological and Magneto rheological Fluids: Mechanisms and Properties, Characteristics, Fluid composition and behaviour, Discovery and Early developments, Summary of material properties. Applications of ER and MR fluids (Clutches, Dampers, others). Fibre Optics: Introduction, Physical Phenomenon, Characteristics, Fibre optic strain sensors, Twisted and Braided Fibre Optic sensors, Optical fibres as load bearing elements, Crack detection applications, Integration of Fibre optic sensors and shape memory elements.	10	Fluids Mechanisms	L2 understand
3	Vibration Absorbers: Introduction, Parallel Damped Vibration Absorber, Analysis, Gyroscopic Vibration absorbers, analysis & experimental set up and observations, Active Vibration absorbers. Control of Structures: Introduction, Structures as control plants, Modelling structures for control, Control strategies and Limitations. Biomimetics: Characteristics of Natural structures. Fibre reinforced: organic matrix natural composites, Natural creamers, Mollusks. Biomimetic sensing, Challenges and oppurtunities.	10	Vibration Absorbers	L2 understand
4	MEMS: History of MEMS, Intrinsic Characteristics, Devices: Sensors and Actuators. Microfabrication: Photolithography, Thermal oxidation, Thin film deposition, etching types, Doping, Dicing, Bonding. Microelectronics fabrication process flow, Silicon based, Process selection and design. Piezoelectric Sensing and Actuation: Introduction, Cantilever Piezoelectric actuator model, Properties of Piezoelectric materials, Applications. Magnetic Actuation: Concepts and Principles, Magnetization and Nomenclatures, Fabrication and case studies, Comparison of major sensing and actuation methods.	10	Microfabrication	L2 understand
5	Polymer MEMS& Micro fluidics: Introduction, Polymers in MEMS(Polyimide, SU-8,LCP,PDMS,PMMA,Parylene, Others) Applications(Acceleration, Pressure, Flow, Tactile sensors). Motivation	10	Polymer MEMS and	L2 understand

	for micro fluidics, Biological Concepts, Design and Fabrication of Selective components. Channels and Valves. Case Studies: MEMS Magnetic actuators, BP sensors, Microphone, Acceleration sensors, Gyro, MEMS Product development: Performance, Accuracy, Repeatability, Reliability, Managing cost, Market uncertainties, Investment and competition.		case studies	

3. Course Material

Module	Details	Available
1	"Smart Structures –Analysis and Design", A.V.Srinivasan, Cambridge University Press, New York, 2001	In Lib
2	Production Technology (Manufacturing process, technology and Automation), R.K Jain, Khanna Publishers-2004	In Lib
3	Smart Materials and Structures", M.V.Gandhi and B.S.Thompson Chapmen & Hall, London, 1992	In Lib
4	Production Technology Vol-II by O. P. Khanna & Lal, Dhanpat Rai Publications-2012.	In Lib
5	"Foundation of MEMS, by Chang Liu. Pearson Education.	In Lib

4. Course Prerequisites

SNo	Course Code	Course Name	Module / Topic / Description	Sem	Remarks	Blooms Level
1	17ME32	MATERIAL SCIENCE	Plastic deformation , true stress and true strain , mechanical properties	III	-	L2 understand
2	10ME553	Manufacturing processes-III	Different material for casting, Engineering materials	V	-	L2 understand

Note: If prerequisites are not taught earlier, GAP in curriculum needs to be addressed. Include in Remarks and implement in B.5.

B. OBE PARAMETERS

1. Course Outcomes

Student able to

#	COs	Teach. Hours	Concept	Instr Method	Assessment Method	Blooms' Level
1	Understand concept of different Smart Structures	05	Smart Structures	Lecture	Assignment ,IA,unit test	L2 understand
2	Understand concept of different Shape Memory Alloys	05	Shape Memory Alloys	Lecture	Assignment ,IA ,unit test	L2 understand
3	Under stand concept of Electro rheological and Magneto rheological Fluids	05	Electro rheological and Magneto rheological Fluids	Lecture	Assignment ,IA ,unit test	L2 understand
4	Understand concept of Fiber Optics	05	Fibre Optics	Lecture	Assignment ,IA ,unit test	L2 understand
5	Understand concept of Vibration	05	Vibration	Lecture	Assignment	L2 understand

	Absorbers		Absorbers		,IA ,unit test	
6	Understand concept of Biomimetics.	05	Biomimetics.	Lecture	Lecture & ppt	Assignment ,IA ,unit test
7	Understand concept of MEMS	05	MEMS	Lecture & ppt	Assignment ,IA ,unit test	L2 understand
8	Understand concept of Micro fabrication	05	Micro-fabrication	Lecture & ppt	Assignment ,IA ,unit test	L2 understand
9	Develop approaches to Polymer MEMS& Micro fluidics	05	Polymer MEMS& Micro fluidics	Lecture & ppt	Assignment ,IA ,unit test	L2 understand
10	Under stand concept of Case Studies: MEMS	05	Case Studies: MEMS	Lecture & ppt	Assignment ,IA ,unit test	L2 understand
-	**Total**	**50**	-	-	-	-

Note: Identify a max of 2 Concepts per Module. Write 1 CO per concept.

2. Course Applications

SNo	Application Area	CO	Level
1	Automobile industries and aerospace	CO1	L2
2	For design of different parts of automobile, electronic and aerospace components	CO2	L2
3	Shock Absorbers	CO3	L2
4	Transmission of data in mobile, internet, tv and other transmission applications	CO4	L2
5	Vibration controllers and dampers	CO5	L2
6	Biomimetics structure, sensors and actuators	CO6	L2
7	MEMS, microfabrication	CO7	L2
8	Dicing, Doping, Bonding. Microelectronics fabrication process for all MEMS products	CO8	L2
9	Acceleration, Pressure, Flow, Tactile sensors fabrication using polymer MEMS	CO9	L2
10	CASE studies for fabrication BP, GYRO, ACCLEROMETERS and microphones	CO10	L2

Note: Write 1 or 2 applications per CO.

3. Articulation Matrix

(CO – PO MAPPING)

-	Course Outcomes	Program Outcomes												
#	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Level
15ME745.1	Understand concept of different Smart Structures	√	-	-	-	-	-	-	-	-	-	-	-	L2
15ME745.2	Understand concept of different Shape Memory Alloys	√	-	-	-	-	-	-	-	-	-	-	-	L2
15ME745.3	Under stand concept of Electro rheological and Magneto rheological Fluids	√	-	-	-	-	-	-	-	–	-	-	-	L2
15ME745.4	Understand concept of Fibre Optics	√	-	-	-	-	√	-	-	-	–	-	-	L2
15ME745.5	Understand concept of Vibration Absorbers	√	-	-	-	-	√	-	-	-	-	-	-	L2
15ME745.6	Understand concept of Biomimetics.	√	-	-	-	-	√	-	-	-	-	-	-	L2
15ME745.7	Understand concept of MEMS	√	-	-	-	-	√	-	–	-	–	-	-	L2
15ME745.8	Understand concept of Microfabrication	√	-	-	-	-	√	-	-	-	-	-	-	L2
15ME745.9	Develop approaches to Polymer MEMS& Micro fluidics	√	-	-	-	-	√	-	-	-	-	-	-	L2
15ME745.10	Under stand concept of Case Studies: MEMS	√	-	-	-	-	-	-	-	-	-	-	-	L2

Note: Mention the mapping strength as 1, 2, or 3

4. Mapping Justification

Mapping		Justification	Mapping Level
CO	**PO**	-	-
CO1	PO1	Knowledge of fundamentals like Smart Structure materials	L2
CO1	PO2	No analysis no mapping	L2
CO1	PO3	No design and development content. No Mapping	L2
CO1	PO4	No investigation and interpretation content,No mapping	L2
CO1	PO5	No tool content no mapping	L2
CO1	PO6	No social and cultural issues,No mapping	L2
CO1	PO7	No environmental contexts,No mapping	L2
CO1	PO8	No ethical principals,No mapping	L2
CO1	PO9	No individual and team work,No mapping	L2
CO1	PO10	No Mapping	L2
CO1	PO11	No Mapping	L2
CO1	PO12	No mapping	L2
CO2	PO1	Understand the need for shape memory alloys process.	L2
CO2	PO2	No analysis no mapping	L2
CO2	PO3	No design and development content. No Mapping	L2
CO2	PO4	No investigation and interpretation content,No mapping	L2
CO2	PO5	No tool content no mapping	L2
CO2	PO6	No social and cultural issues,No mapping	L2
CO2	PO7	No environmental contexts,No mapping	L2
CO2	PO8	No ethical principals,No mapping	L2
CO2	PO9	No individual and team work,No mapping	L2
CO2	PO10	No Mapping	L2
CO2	PO11	No Mapping	L2
CO2	PO12	No mapping	L2
CO3	PO1	Knowledge of constructional features, performance parameters required	L2
CO3	PO2	No analysis no mapping	L2
CO3	PO3	No design and development content. No Mapping	L2
CO3	PO4	No investigation and interpretation content,No mapping	L2
CO3	PO5	No tool content no mapping	L2
CO3	PO6	No social and cultural issues,No mapping	L2
CO3	PO7	No environmental contexts,No mapping	L2
CO3	PO8	No ethical principals,No mapping	L2
CO3	PO9	No individual and team work,No mapping	L2
CO3	PO10	No Mapping	L2
CO3	PO11	No Mapping	L2
CO3	PO12	No mapping	L2
CO4	PO1	Understand the need for Non-traditional machining process.	L2
CO4	PO2	No analysis no mapping	L2
CO4	PO3	No design and development content. No Mapping	L2
CO4	PO4	No investigation and interpretation content,No mapping	L2
CO4	PO5	No tool content no mapping	L2
CO4	PO6	No social and cultural issues,No mapping	L2
CO4	PO7	No environmental contexts,No mapping	L2

CO4	PO8	No ethical principals,No mapping	L2
CO4	PO9	No individual and team work,No mapping	L2
CO4	PO10	No Mapping	L2
CO4	PO11	No Mapping	L2
CO4	PO12	No mapping	L2
CO5	PO1	understand constructional features and performance of ECM.	L2
CO5	PO2	No analysis no mapping	L2
CO5	PO3	No design and development content. No Mapping	L2
CO5	PO4	No investigation and interpretation content,No mapping	L2
CO5	PO5	No tool content no mapping	L2
CO5	PO6	Educate students about environmental and safety issues.	L2
CO5	PO7	No environmental contexts,No mapping	L2
CO5	PO8	No ethical principals,No mapping	L2
CO5	PO9	No individual and team work,No mapping	L2
CO5	PO10	No Mapping	L2
CO5	PO11	No Mapping	L2
CO5	PO12	No mapping	L2
CO6	PO1	understand constructional features and performance of CHM.	L2
CO6	PO2	No analysis no mapping	L2
CO6	PO3	No design and development content. No Mapping	L2
CO6	PO4	No investigation and interpretation content,No mapping	L2
CO6	PO5	No tool content no mapping	L2
CO6	PO6	Educate students about environmental and safety issues.	L2
CO6	PO7	No environmental contexts,No mapping	L2
CO6	PO8	No ethical principals,No mapping	L2
CO6	PO9	No individual and team work,No mapping	L2
CO6	PO10	No Mapping	L2
CO6	PO11	No Mapping	L2
CO6	PO12	No mapping	L2
CO7	PO1	Knowledge of constructional features and performance of EDM.	L2
CO7	PO2	No analysis no mapping	L2
CO7	PO3	No design and development content. No Mapping	L2
CO7	PO4	No investigation and interpretation content,No mapping	L2
CO7	PO5	No tool content no mapping	L2
CO7	PO6	Educate students about environmental and safety issues.	L2
CO7	PO7	No environmental contexts,No mapping	L2
CO7	PO8	No ethical principals,No mapping	L2
CO7	PO9	No individual and team work,No mapping	L2
CO7	PO10	No Mapping	L2
CO7	PO11	No Mapping	L2
CO7	PO12	No mapping	L2
CO8	PO1	understand constructional features and performance of PAM.	L2
CO8	PO2	No analysis no mapping	L2
CO8	PO3	No design and development content. No Mapping	L2
CO8	PO4	No investigation and interpretation content,No mapping	L2
CO8	PO5	No tool content no mapping	L2
CO8	PO6	Educate students about environmental and safety issues.	L2

CO8	PO7	No environmental contexts,No mapping	L2
CO8	PO8	No ethical principals,No mapping	L2
CO8	PO9	No individual and team work,No mapping	L2
CO8	PO10	No Mapping	L2
CO8	PO11	No Mapping	L2
CO8	PO12	No mapping	L2
CO9	PO1	Knowledge of constructional features and performance of LBM.	L2
CO9	PO2	No analysis no mapping	L2
CO9	PO3	No design and development content. No Mapping	L2
CO9	PO4	No investigation and interpretation content,No mapping	L2
CO9	PO5	No tool content no mapping	L2
CO9	PO6	Educate students about environmental and safety issues.	L2
CO9	PO7	No environmental contexts,No mapping	L2
CO9	PO8	No ethical principals,No mapping	L2
CO9	PO9	No individual and team work,No mapping	L2
CO9	PO10	No Mapping	L2
CO9	PO11	No Mapping	L2
CO9	PO12	No mapping	L2
CO10	PO1	Student should be able to understand constructional features and performance of EBM.	L2
CO10	PO2	No analysis no mapping	L2
CO10	PO3	No design and development content. No Mapping	L2
CO10	PO4	No investigation and interpretation content,No mapping	L2
CO10	PO5	No tool content no mapping	L2
CO10	PO6	Educate students about environmental and safety issues.	L2
CO10	PO7	No environmental contexts,No mapping	L2
CO10	PO8	No ethical principals,No mapping	L2
CO10	PO9	No individual and team work,No mapping	L2
CO10	PO10	No Mapping	L2
CO10	PO11	No Mapping	L2
CO10	PO12	No mapping	L2

Note: Write justification for each CO-PO mapping.

5. Curricular Gap and Content

SNo	Gap Topic	Actions Planned	Schedule Planned	Resources Person	PO Mapping
1					
2					
3					
4					
5					

Note: Write Gap topics from A.4 and add others also.

6. Content Beyond Syllabus

SNo	Gap Topic	Actions Planned	Schedule Planned	Resources Person	PO Mapping
1	Si manufacturing for si board				

ME

Prepared by Checked by Approved

2					
3					
4					
5					
6					
7					
8					
9					
10					

Note: Anything not covered above is included here.

C. COURSE ASSESSMENT

1. Course Coverage

Module #	Title	Teaching Hours	No. of question in Exam						CO	Levels
			CIA-1	CIA-2	CIA-3	Asg	Extra Asg	SEE		
1	Shape Memory Alloys	10	2	-	-	1	1	4	CO1, CO2	L2, L2
2	Fiber optics	10	2	-	-	1	1	4	CO3, CO4	L2, L2
3	Vibration Absorbers	10	-	2	-	2	1	4	CO5 CO6	L2, L2
4	Microfabrication	10	-	2	-	2	1	4	CO7, CO8	L2, L2
5	Polymer MEMS	10	-	-	4	3	1	4	CO9 CO10	L2, L2
-	**Total**	**50**	**4**	**4**	**4**	**5**	**5**	**20**	-	-

Note: Distinct assignment for each student. 1 Assignment per chapter per student. 1 seminar per test per student.

2. Continuous Internal Assessment (CIA)

Evaluation	Weightage in Marks	CO	Levels
CIA Exam – 1	15	CO1, CO2, CO3, CO4	L2, L2, L2, L2
CIA Exam – 2	15	CO5, CO6, CO7, CO8	L2, L2, L2, L2
CIA Exam – 3	15	CO9, CO10	L2, L2
Assignment - 1	5	CO1, CO2, CO3, CO4	L2, L2, L2, L2
Assignment - 2	5	CO5, CO6, CO7, CO8	L2, L2, L2, L2
Assignment - 3	5	CO9, CO10	L2, L2
Seminar - 1	-	CO2, CO3, CO4	L2, L2, L2
Seminar - 2	-	CO5, CO6, CO7, CO8	L2, L2, L2, L2
Seminar - 3	-	CO9, CO10	L2, L2
Other Activities – define – Slip test			
Final CIA Marks	**20**	-	-

Note : Blooms Level in last column shall match with A.2 above.

D1. TEACHING PLAN - 1

Module - 1

Title:	Introduction to SMART MATERIAL & MEMS	Appr	10 Hrs

ME

Prepared by Checked by Approved

		Time:	
a	***Course Outcomes***	-	**Blooms**
-	student should be able to:	-	**Level**
1	Understand the concept of different metal forming process	CO1	L2
2	Understand the concept of different stress -strain in metal forming	CO2	L2
b	***Course Schedule***	-	-
Class No	**Module Content Covered**	**CO**	**Level**
1	Introduction: Closed loop and Open loop Smart Structures.	C01	L2
2	Applications of Smart structures, Piezoelectric properties	C01	L2
3	Inchworm Linear motor, Shape memory alloys	C01	L2
4	Shape memory effect-Application	C01	L2
5	Processing and characteristics	C01	L2
6	Shape Memory Alloys: Introduction, Phenomenology	C02	
7	Influence of stress on characteristic temperatures,	C02	L2
8	Modelling of shape memory effect.	C02	L2
9	Vibration control through shape memory alloys. Design considerations,	C02	L2
10	multiplexing embedded NiTiNOL actuators.	C02	L2
c	**Application Areas**	**CO**	**Level**
1	Automobile industries and aerospace	CO1	L2
2	For design of different parts of automobile, electronic and aerospace components	CO2	L2
3	Shock Absorbers		
4			
d		-	-
1		CO1	L2
2		CO1	L2
3		CO1	L2
4			L2
5			L2
6	Discuss the vibration control through shape memory alloys.	CO2	L2
7	Discuss the advantages of multiplexing embedded NiTiNOL actuators.	CO2	L2
8	Explain the vibration control using a NiTiNOL wire suspended mass system at the free end of the beam.	CO2	L2
9	Explain the concepts of deformation mechanisms.	CO2	L2
e	**Experiences**	-	-
1		CO1	L2

Module – 2

Title:	Forging and their parameters	Appr Time:	10 Hrs
a	***Course Outcomes***	-	**Blooms**
-	student should be able to:	-	**Level**
1	Forging equipments and their die design parameters	CO3	L2
2	Defects in forging	CO4	L3
b	***Course Schedule***	-	-

Class No	Module Content Covered	CO	Level
11	Electro rheological and Magneto rheological Fluids	CO3	L2
12	Mechanisms and Properties,Characteristics	CO3	L2
13	Fluid composition and behaviour, Discovery and Early developments	CO3	L2
14	Summary of material properties.	CO3	L2
15	Applications of ER and MR fluids (Clutches, Dampers, others).	CO3	L2
16	Fibre Optics: Introduction, Physical Phenomenon	CO4	L2
17	Characteristics, Fibre optic strain sensors	CO4	L2
18	Twisted and Braided Fibre Optic sensors	CO4	L2
19	Optical fibres as load bearing elements, Crack detection applications.	CO4	L2
20	Integration of Fibre optic sensors and shape memory elements.	CO4	L3
c	**Application Areas**	**CO**	**Level**
1	Transmission of data in mobile, internet, tv and other transmission applications	CO3	L2
2	Vibration controllers and dampers		L2
3	Biomimetics structure, sensors and actuators	CO4	L2
4	MEMS, microfabrication		L2
d	Dicing, Doping, Bonding. Microelectronics fabrication process for all MEMS products	-	-
1	Acceleration, Pressure, Flow, Tactile sensors fabrication using polymer MEMS	CO3	L2
2	CASE studies for fabrication BP, GYRO, ACCLEROMETERS and microphones	CO3	L2
3	Explain any one model predicting the Pre-yield behaviour in MR/ER fluids.	CO3	L2
4	Discuss the applications of MR/ER fluids in clutches.	CO3	L2
5	Explain Fluid composition and behaviour.	CO3	L2
6	Explain the principle of total internal reflection in optical fibers.	CO4	L2
7	Explain the working principle of fiber optics in crack detection.	CO4	L2
8	Explain the principle of total internal reflection in optical fibers.	CO4	L2
9	List the applications of optical fibers as sensors.	CO4	L2
10	Explain the shape memory elements.	CO4	L2
11		-	-
		CO1	L2

E1. CIA EXAM – 1

a. Model Question Paper - 1

Crs Code:	15ME745	Sem:	VI	Marks:	20	Time:	75 minutes
Course	SMART MATERIAL & MEMS						

-	-	Note:Answer any ONE FULL question from each Module	Marks	CO	Level
1	a	What are smart materials? Explain its applications in various fields.	5	CO1	L2
	b	Explain shape memory effect. List the applications of shape memory alloys.	5	CO1	L2
		OR			
2	a	Discuss the vibration control through shape memory alloys.	5	CO2	L2
	b	Discuss the advantages of multiplexing embedded NiTiNOL actuators.	5	CO2	L2
3	a	List the Properties & characteristics of MR/ER fluids.	5	CO3	L2
	b	Discuss the applications of MR/ER fluids in Dampers.	5	CO3	L2
		OR			
4	a	Explain the principle of total internal reflection in optical fibers.	5	CO4	L2

	b	Explain the working principle of fiber optics in crack detection.	5	CO4	L2

b. Assignment -1

Note: A distinct assignment to be assigned to each student.

Model Assignment Questions							
Crs Code:	15ME745	Sem:	VI	Marks:	20	Time:	
Course:	SMART MATERIAL & MEMS						
Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.							

SNo	USN	Assignment Description	Marks	CO	Level
1		What are smart materials? Explain its applications in various fields.	5	CO1	L2
2		Explain shape memory effect. List the applications of shape memory alloys.	5	CO1	L2
3		What are smart materials? Explain its applications in various fields.	5	CO1	L3
4		Explain Piezo electric effect. Describe the working of Inch worm linear motor with neat sketch.	5	CO1	L2
5		Explain with neat sketches the one-way & two-way shape memory effect.	5	CO1	L2
6		Discuss the vibration control through shape memory alloys.	5	CO1	L2
7		Discuss the advantages of multiplexing embedded NiTiNOL actuators.	5	CO1	L2
8		Explain the vibration control using a NiTiNOL wire suspended mass system at the free end of the beam.			
9		Explain the concepts of deformation mechanisms.			
10		List the Properties & characteristics of MR/ER fluids.	5	CO1	L2
11		Discuss the applications of MR/ER fluids in Dampers.	6	CO1	L2
12		Explain any one model predicting the Pre-yield behaviour in MR/ER fluids.	4	CO1	L2
13		Discuss the applications of MR/ER fluids in clutches.	6	CO1	L2
14		Explain Fluid composition and behaviour.	5	CO2	L2
15		Explain the principle of total internal reflection in optical fibers.	4	CO2	L2
16		Explain the working principle of fiber optics in crack detection.	6	CO2	L2
17		Explain the principle of total internal reflection in optical fibers.		CO2	L2
18		List the applications of optical fibers as sensors.		CO2	L2
19		Explain the shape memory elements.		CO2	L2
20		List the Properties & characteristics of MR/ER fluids.		CO2	L2
21		Discuss the applications of MR/ER fluids in Dampers.		CO2	L2
22		Explain any one model predicting the Pre-yield behaviour in MR/ER fluids.		CO2	L2

D2. TEACHING PLAN - 2

Module – 3

Title:		Appr Time:	11Hrs
a	***Course Outcomes***	**-**	**Blooms**

-	student should be able to:	-	**Level**
1	Understand the rolling , drawing and extrusionprocess	CO4	L2
b	***Course Schedule***		
Class No	**Module Content Covered**	**CO**	**Level**
21	Vibration Absorbers: Introduction	CO5	L2
22	Parallel Damped Vibration Absorber, Analysis,,	CO5	L2
23	Parallel Damped Vibration Absorber, Analysis,,	CO5	L2
24	Gyroscopic Vibration absorbers	CO5	L2
25	analysis & experimental set up and observations,	CO5	L2
26	Active Vibration absorbers. Control of Structures: Introduction,	CO6	L2
27	Structures as control plants,Modelling structures for control,	CO6	L2
28	Control strategies and Limitations.Biomimetics: Characteristics of Natural structures.	CO6	L2
29	Fibre reinforced: organic matrix natural composites,	CO6	L2
30	Natural creamers, Mollusks. Biomimetic sensing,	CO6	L2
31	Challenges andoppurtunities.	CO6	L2
c	**Application Areas**	**CO**	**Level**
1		CO6	L2
d	**Review Questions**	-	-
1	With neat sketch, explain different types of rolling mill arrangements.	CO5	L2
2	Explain the defects of rolled product.	CO5	L2
3	In rolling a slab from 35 to 30 nun calculate the coefficient of friction and the length of arc of contact. Take the value of roll radius as 250 mm.	CO5	L2
4	4 a. Explain the following with neat figures: i) Four high rolling mill ii) Cluster rolling mil! iii) Tandem mill iv) Planetary rolling mill	CO5	L2
5	Determine the maximum possible reduction for cold rolling of a 300 mm thick slab when = 0.8 and roll diameter 600mm . What is the maximum reduction on the same mill for hot rolling when = 0.5?	CO5	L2
6	With a neat sketch, explain planetary rolling mill.	CO5	L2
7	Calculate the rolling load if a steel is hot rolled from a 40mm thick slab of width 760mm.The reduction in thickness achieved is 30% and the roll diameter is 900mm. The plane strain flow stress is 140 MPa at the entrance and 200 MPa at the exit from the roll gap because of the increasing velocity. Assume the co -efficient of friction as 0.3. If the roll speed is 100 rpm, what is power required to drive the rolls?	CO6	L2
8	Describe the effect of front and back tension on the rolling load.	CO6	L2
9	Explain with neat sketches any three types of rolling mills. Calculate the rolling load if a steel sheet is hot rolled from a 40 mm thick slab of width 760.The reduction in thickness achieved is 30% and the roll diameter is 900 mm. The plain strain flow stress is 140 MPa at entrance and 200 MPa at the exit from the roll gap because of the increasing velocity. Assume the coefficient of friction as 0.3. If the roll speed is 100 rpm,what is power required to drive the rolls	CO6	L2
10	Explain with neat sketches the wire drawing and rod drawing operations	CO6	L2
11	Explain the defects in rolled products with neat sketches.		L2
e	**Experiences**	-	-
1		CO1	L2

Module – 4

Title:	**Extrusion and sheet metal forming**	Appr Time:	10 Hrs
a	***Course Outcomes***	-	**Blooms**

-	student should be able to:	-	**Level**
1	Understand the Process of extrusion and sheet metal forming method		
b	***Course Schedule***		
Class No	**Module Content Covered**	**CO**	**Level**
32	MEMS: History of MEMS, Intrinsic Characteristics, Devices:Sensors and Actuators.	CO7	
33	Microfabrication: Photolithography, Thermal oxidation, Thin film deposition	CO7	L2
34	etching types, Doping, Dicing, Bonding.	CO7	L2
35	Microelectronics fabrication process flow, Silicon based, Process selection and design.	CO7	L2
36	Piezoelectric Sensing and Actuation: Introduction	CO7	L2
37	Cantilever Piezoelectric actuatormodel	CO8	L2
38	Properties of Piezoelectric materials, Applications	CO8	L2
39	Magnetic Actuation: Concepts and Principles	CO8	L2
40	Magnetization and Nomenclatures, Fabrication and case studies	CO8	L2
41	Comparison of major sensing and actuation methods.	CO8	L2
c	**Application Areas**	**CO**	**Level**
1	Extrusion is widely used in production of tubes and hollow pipes. Aluminum . Extrusion is used in structure work in many industries. This process is used to produce frames, doors, window etc. in automotive industries.	CO7	L2
2	Sheet metal is used in the home appliance industry to create freezers, hoods, and sinks.	CO8	L2
d	**Review Questions**	-	-
1	Give the classification of extrusion process and explain hydrostatic extrusion.	CO7	L2
2	Explain in detail the deformation equipments and defects in extrusion.	CO7	L2
3	Write a note on extrusion equipment and die design.	CO7	L2
4	Explain the manufacture of seamless tubes, with neat sketch.	CO7	L2
5	Give the classification of extrusion process and explain forward extrusion process with a neat sketch	CO7	L2
6	How seamless pipes and tubes can be produced by extrusion? Explain with a neat sketch.	CO7	L2
7	Briefly explain four extrusion defects with their causes and remedies.	CO8	L2
8	It is required to extrude cylindrical aluminium billet of 50mm diameter to 10mm diameter . The length of billet is 75mm and the average yield stress for aluminium material is 170N/mm^2. Calculate the force required for extrusion . Assume =0.15 and semi die- angle = 45^0.	CO8	L2
9	Give the classification of extrusion process and explain forward extrusion process with a neat sketch	CO8	L2
10	How seamless pipes and tubes can be produced by extrusion? Explain with a neat sketch.	CO8	L2
11	Explain in detail the deformation equipments and defects in extrusion.	CO8	L2
12	Briefly explain four extrusion defects with their causes and remedies.	CO8	L2
e	**Experiences**	-	-
1			

E2. CIA EXAM – 2

a. Model Question Paper - 2

Crs Code:	15ME745	Sem:	VI	Marks:	20	Time:	75 minutes		
Course:	SMART MATERIAL & MEMS								
-	-	**Note: Answer any 2 questions, each carry equal marks.**					**Marks**	**CO**	**Level**
1	a	Write a short note on active vibration absorbers					8	CO5	L2
	b	Explain briefly the smart control of structures.					7	CO5	L2

		OR			
2	a	Explain briefly the intrinsic characteristics of natural structures.	7	CO6	L2
	b	Discuss the structural design of wood as fiber- reinforced matrix.	8	CO6	L2
		OR			
3	a	Explain briefly the intrinsic characteristics of MEMS.	7	CO7	L2
	b	Explain with neat sketch, thermal oxidation fabrication of MEMS.	8	CO7	L2
		OR			
4	a	Explain working of Cantilever Piezoelectric Accelerometer.	8	CO8	L2
	b	List major methods of sensing & actuation.	7	CO8	L2

b. Assignment – 2

Note: A distinct assignment to be assigned to each student.

Model Assignment Questions							
Crs Code:	15ME745	Sem:	VI	Marks:	10	Time:	90 minutes
Course:	SMART MATERIAL & MEMS						

Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.

SNo	USN	Assignment Description	Marks	CO	Level
1		Explain briefly the intrinsic characteristics of natural structures.	7	CO5	L2
2		Discuss the structural design of wood as fiber- reinforced matrix.	5	CO5	L2
3		Write a short note on active vibration absorbers	5	CO5	L2
4		Explain briefly the smart control of structures.	5	CO5	L2
5		Explain briefly the intrinsic characteristics of MEMS.	5	CO5	L2
6		Explain with neat sketches tandem mill and four high rolling mill.			
7		Explain optimal cone angle and dead zone formation in drawing with sketches.			
8		Explain with neat sketches the wire drawing and rod drawing operations.			
9		Explain the defects in rolled products with neat sketches.			
10		Explain extrusion piping and Chevron cracking defects in extrusion.			
11		With neat sketches, explain rubber forming and stretch forming.			
12		Explain any four extrusion process variables with sketch			
13		Explain combination die and progressive die with neat sketches.			
14		Explain optimal cone angle and dead zone formation in drawing with sketches.			
15		Explain with neat sketches the wire drawing and rod drawing operations.			
16		Explain the defects in rolled products with neat sketches.			
17		Explain extrusion piping and Chevron cracking defects in extrusion.			
18		With neat sketches, explain rubber forming and stretch forming.			
19		Explain any four extrusion process variables with sketch			
20		Explain combination die and progressive die with neat sketches.			

D3. TEACHING PLAN - 3

Module – 5

Title:	Powder metallurgy & high energy forming method	Appr Time:	11Hrs
a	***Course Outcomes***	-	**Blooms**
-	student should be able to:	-	**Level**

1	Understand the process of powder metallurgy technique and high energy forming method	CO8	L2
b	***Course Schedule***		
Class No	**Module Content Covered**	**CO**	**Level**
42	Polymer MEMS& Micro fluidics: Introduction, Polymers in MEMS.	CO9	L2
43	Polyimide, SU-8,LCP,PDMS,PMMA,Parylene, Others Applications Acceleration, Pressure, Flow, Tactile sensors	CO9	L2
44	Motivation for micro fluidics	CO9	L2
45	Biological Concepts	CO9	L2
46	Design and Fabrication of Selective components. Channels and Valves.	CO9	L2
47	Case Studies: MEMS Magnetic actuators, BP sensors,	CO10	L2
48	Microphone	CO10	L2
49	Acceleration sensors, Gyro	CO10	L2
50	MEMS Product development: Performance, Accuracy, Repeatability	CO10	L2
51	Reliability, Managing cost, Market uncertainties	CO10	L2
52	Investment and competition.	CO10	
c	**Application Areas**	**CO**	**Level**
1	powder metallurgy is used in filters, cutting tools and die, Machinery Parts , bearing and bushes, magnets	CO9	L2
d	**Review Questions**	-	-
1	List any three materials for polymer MEMS.	CO9	L2
2	Discuss the design & fabrication of channels & valves.	CO9	L2
3	Discuss the design considerations of MEMS sensors in blood pressure monitoring of patients.	CO9	L2
4	Discuss the design of gyro MEMS in automobiles.	CO9	L2
5	List the applications where polymer MEMS are a success. Discuss any two.		L2
6	Explain the fabrication of MEMS pressure sensors in detail.	CO10	L2
7	Discuss the design considerations of MEMS sensors in microphones.	CO10	L2
8	Explain briefly the top concerns for MEMS product development .	CO10	L2
9	List explosive forming advantages, disadvantages and applications.	CO10	L2
10	Explain atomization with sketch and electrolytic deposition.	CO10	L2
11	Briefly explain continuous roll compaction with sketch.	CO10	L2
e	**Experiences**	-	-
1			

E3. CIA EXAM – 3

a. Model Question Paper - 3

Crs Code:	15ME745	Sem:	VI	Marks:	30	Time:	75 minutes		
Course:	SMART MATERIAL & MEMS								
-	**-**	**Note: Answer any 2 questions, each carry equal marks.**					**Marks**	**CO**	**Level**
1	a	List any three materials for polymer MEMS.					8	CO9	L2
	b	Discuss the design & fabrication of channels & valves.					7	CO9	L2
		OR							
2	a	Discuss the design considerations of MEMS sensors in blood pressure monitoring of patients.					8	CO9	L2
	b	Discuss the design of gyro MEMS in automobiles.					7	CO9	L2

3	a	Explain atomization with sketch and electrolytic deposition.	7	CO10	L2
	b	Briefly explain continuous roll compaction with sketch.	8	CO10	L2
		OR			
4	a	Explain briefly the top concerns for MEMS product development .	7	CO10	L2
	b	List explosive forming advantages, disadvantages and applications.	8	CO10	L2

b. Assignment – 3

Note: A distinct assignment to be assigned to each student.

Model Assignment Questions							
Crs Code:	15ME745	Sem:	VI	Marks:	10	Time:	
Course:	SMART MATERIAL & MEMS						

Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.

SNo	USN	Assignment Description	Marks	CO	Level
1		List any three materials for polymer MEMS.	5	CO9	L2
2		Discuss the design & fabrication of channels & valves.	5	CO9	L2
3		Discuss the design considerations of MEMS sensors in blood pressure monitoring of patients.	5	CO9	L2
4		Discuss the design of gyro MEMS in automobiles.	5	CO9	L2
5		List the applications where polymer MEMS are a success. Discuss any two.	5	CO9	L2
6		Explain the fabrication of MEMS pressure sensors in detail.	5	CO9	L2
7		Discuss the design considerations of MEMS sensors in microphones.	5	CO9	L2
8		Explain briefly the top concerns for MEMS product development .	5	CO9	L2
9		List explosive forming advantages, disadvantages and applications.	5	CO9	L2
10		Explain atomization with sketch and electrolytic deposition.	5	CO10	L2
11		Briefly explain continuous roll compaction with sketch.	5	CO10	L2
12		List any three materials for polymer MEMS.	5	CO10	L2
13		Discuss the design & fabrication of channels & valves.	5	CO10	L2
14		Discuss the design considerations of MEMS sensors in blood pressure monitoring of patients.	5	CO10	L2
15		Discuss the design of gyro MEMS in automobiles.	5	CO10	L2

F. EXAM PREPARATION

1. University Model Question Paper

Course:	SMART MATERIAL & MEMS					Month / Year	Dec/2018
Crs Code:	15ME745	Sem:	VI	Marks:	100	Time:	180 minutes

-	Note	Answer all FIVE full questions. All questions carry equal marks.	Marks	CO	Level
1	a	What are smart materials? Explain its applications in various fields.	10	CO1	L2
	b	Explain shape memory effect. List the applications of shape memory alloys.	6	CO1	L2
		OR			
2	a	Discuss the advantages of multiplexing embedded NiTiNOL actuators.	6	CO2	L2
	b	Explain the vibration control using a NiTiNOL wire suspended mass system at the free end of the beam.	10	CO2	L2
3	a	Explain any one model predicting the Pre-yield behaviour in MR/ER fluids	7	CO3	L2

	b	Discuss the applications of MR/ER fluids in clutches.	9	CO3	L2
		OR			
4	a	Explain the principle of total internal reflection in optical fibers.	12	CO4	L2
	b	List the applications of optical fibers as sensors.	4	CO4	L2
5	a	Write a short note on active vibration absorbers	8	CO5	L2
	b	Explain briefly the smart control of structures.	8	CO5	L2
		OR			
6	a	Discuss briefly the challenges & opportunities of bio-mimetics.	8	CO6	L2
	b	Discuss the micro structural design of toughness mechanism in mollusks.	8	CO6	L2
7	a	Explain briefly the intrinsic characteristics of MEMS.	8	CO7	L3
	b	Explain with neat sketch, thermal oxidation fabrication of MEMS.	8	CO7	L2
		OR			
8	a	List the properties of Piezo –electric materials.	6	CO8	L2
	b	Explain in detail the working of Piezo-electric tactile sensors.	10	CO8	L2
9	a	List the applications where polymer MEMS are a success. Discuss any two.	8	CO9	L2
	b	Explain the fabrication of MEMS pressure sensors in detail.	8	CO9	L2
		OR			
10	a	Discuss the design considerations of MEMS sensors in microphones.	8	CO10	L2
	b	Explain briefly the top concerns for MEMS product development .	5	CO10	L2

2. SEE Important Questions

Course:		SMART MATERIAL & MEMS					Month / Year	Dec /2018	
Crs Code:		15ME745	Sem:	III	Marks:	100	Time:	180 minutes	
	Note	Answer all FIVE full questions. All questions carry equal marks.					-	-	
Module	Qno.	Important Question					**Marks**	**CO**	**Year**
1	1	What are smart materials? Explain its applications in various fields.					6	CO1	2017
	2	Explain Piezo electric effect. Describe the working of Inch worm linear motor with neat sketch.					6	CO1	2016
	3	Discuss the advantages of multiplexing embedded NiTiNOL actuators.					8	CO2	2016
	4	Explain the vibration control using a NiTiNOL wire suspended mass system at the free end of the beam.					8	CO2	2017
2	1	Explain the principle of total internal reflection in optical fibers.					6	CO3	2015
	2	Explain any one model predicting the Pre-yield behaviour in MR/ER fluids					6	CO3	2017
	3	Discuss the applications of MR/ER fluids in clutches.					8	CO3	2016
3	1	Discuss briefly the challenges & opportunities of bio-mimetics.					8	CO5	2017
	2	Discuss the micro structural design of toughness mechanism in mollusks.					6	CO5	2016
	3	Write a short note on active vibration absorbers					6	CO6	2015
	4	Explain briefly the smart control of structures.					8	CO6	2015
4	1	Explain briefly the intrinsic characteristics of MEMS.					8	CO7	2004
	2	Explain with neat sketch, thermal oxidation fabrication of MEMS.					6	CO7	2015
	3	List the properties of Piezo –electric materials.					6	CO8	2016
	4	Explain in detail the working of Piezo-electric tactile sensors.						CO8	
5	1	List the applications where polymer MEMS are a success. Discuss any two.					8	CO9	2016
	2	Explain the fabrication of MEMS pressure sensors in detail.					6	CO9	2015
	3	Discuss the design considerations of MEMS sensors in microphones.					6	CO10	2017
	4	Explain briefly the top concerns for MEMS product development .					8	CO10	2017