Semester	**I/II**		
Course Title:	**SMART MATERIALS**		
Course Code:	**BETCK105A/205A**	CIE Marks	50
Course Type (Theory/Practical/Integrated)	Theory	SEE Marks	50
		Total Marks	100
Teaching Hours/Week (L:T:P:S)	3:0:0:0	Exam Hours	03
Total Hours of Pedagogy	40 hours Theory	Credits	03

Course Learning Objectives

CLO1: To introduce students to various classes of stimuli responsive materials
CLO2: To develop molecular/atomic level understanding of the smart behavior in the materials
CLO3: To signify the huge potential/crucial role of smart materials/systems in the future technology development.
CLO4: To understand different types of smart materials and their properties

Teaching-Learning process

1. Classroom teaching through chalk & talk, PPT, Appropriate Videos, etc
2. To have a related Industrial visit
3. Activity based learning
4. Display the sample materials in class room/ laboratory
5. Support and guide the students for self–study.
6. State the need for the subject in the present scenario and Provide real-life examples to understand them
7. Show short related video lectures related to each module.

Module-1: Introduction to Smart Materials (8hours)

Self study: Overview of Smart materials and engineering materials and alloys

Introduction and Characteristics of metals, polymers and ceramics. Introduction to smart materials. Classification of smart materials, Components of a smart System, Applications of smart material.

Applications: Acoustic and Industrial Applications, Modification of properties.

(**RBT Levels: L1, L2 and L3)**

Module-2: Smart polymers (8 hours)

Self Study: Overview of polymers and their synthesis, UV radiation curing of polymers.

Thermally responsive polymers, Electro active polymers microgels, Synthesis, Properties and Applications, Protein-based smart polymers, pH-responsive and photo responsive polymers.

Application: Manufacturing of smart polymers with suitable techniques.

(RBT Levels: L1, L2 and L3)

Module-3: Piezoelectric Materials (8 hours)

Self study: Constitutive relationship, eletromechanical coupling coefficients, Polyvinyldene fliuoride.

Piezoelectric constants, Piezoceramic materials, variation of coupling coefficients in hard and soft piezoceramics, polycrystalline v/s single crystal piezoelectric materials, piezoelectric composites.

Applications: Piezoelectric transducers, Piezoelectric sensors, Piezoelectric biomaterials, Piezoelectric diesel injectors, Actuators, Automotive sensors and Structural health-monitoring systems.

(RBT Levels: L1, L2 and L3)

Module-4: Magnetostrictive Materials (8 hours)

Self Study: Constitutive relationship, magneto-mechanical coupling coefficients, Terfenol-D particulate composites.

Joule Effect, Villari Effect, Matteuci Effect, Wiedemann Effect, Gaint magnetostriction in Terfenol-D, Galfenol and Metglas materials.

Applications: Sensors, Transformers, Medical devices, Industrial vibrators, Vibration energy harvester, Vehicle suspension components, Ultrasonic cleaning devices and Intelligent structures.

(RBT Levels: L1, L2 and L3)

Module-5: Shape Memory Alloys (SMA) (8 hours)

Self study: Martensitic materials and their transformations, Future trends in wearable technologies.

Phenomenology, Classification - Transformation - Ni-Ti Alloys, Shape memory effect, Martensitic transformation, One way and two-way SME, binary and ternary alloy systems, Functional properties of SMAs, Shape memory ceramics - Shape memory polymers.

Applications: Shape memory alloy behavior by transformations induced by heat, stresses, and forces on material and structures.

(RBTLevels:L1,L2andL3)

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

CO1: Students will get introduced to ‘intelligence’ and smart behavior in materials
CO2: The vast potential of smart materials will encourage students to explore them in detail.
CO3: To design smart materials for specific applications.
CO4: The course would also enable the students to appreciate the huge role of inspiration in the design of next generation materials.

Course Assessment and Evaluation Details (both CIE and SEE)		
Continuous Internal Evaluation: 50marks		
Theory Assessment Tool	**Marks**	**Average Reduced marks**
IAT-1	50	**25**
IAT-2	50	
Assessment -1 (activity based)	25	**25**
Assessment -2 (activity based)	25	
Semester End Examination (SEE) : 50marks		
SEE	**Marks**	**Reduced marks**
Course end examination (Answer any one question from each unit – Internal choice)	**100**	**50**

Suggested Learning Resources:

Books (Title of the Book/Name of the author/Name of the publisher/Edition and Year) Text Books

1. D.J. Leo, Engineering Analysis of Smart Material Systems, Wiley-2007.
2. M.V. Gandhi, B.D. Thompson, Smart Materials and Structures, Chapman & Hall, 1992.

Reference Books

1. Ralph C Smith, North Carolina State University, Smart Material Systems Model Development, Society for Industrial and Applied Mathematics, Philadelphia
2. K. Otsuka, C.M. Wayman (Eds.), Shape Memory Materials, Cambridge University Press, 1998.
3. P. Ball, Madeto Measure: Materials for the 21st Century, Princeton University Press, 1997.
4. M. Addington, D.L. Schodek, Smart Materials and New Technologies in Architecture, Elsevier2005

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=4-_rwDgLMpk
- https://www.youtube.com/watch?v=s8XmJPrYOQE
- https://www.youtube.com/watch?v=yXHlIowQntk
- https://www.digimat.in/nptel/courses/video/112104251/L01.html
- Smart materials intelligent system design NPTEL course

Activity Based Learning (Suggested Activities in Class)/Practical Based Learning

- Prepare a smart material sample
- Explore smart materials.
- Design & fabricate smart materials.
- Use smart materials in projects.
- Industrial visit.

COs	**POs**												**PSO1**	**PSO2**
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**		
CO1	3	0	0	0	0	1	1	1	1	1	0	1	2	1
CO2	3	0	0	0	1	2	1	1	1	1	0	1	2	1
CO3	3	0	0	0	1	2	1	1	1	1	0	1	2	1
CO4	3	0	0	0	1	2	1	1	1	1	2	2	2	2

Level 3-Highly Mapped, Level 2- Moderately Mapped, Level 1- Low Mapped, Level 0- Not Mapped