Course Code	Course Name	Credits
MEDLO8052	**Smart Materials**	**03**

Objectives

1. To study the working principles of various smart materials.
2. To identify applicability of various smart materials as actuator and sensor.
3. To study advances in smart materials

Outcomes: Learner will be able to…

1 Classify and select different types of smart materials
2. Comprehend Important Concepts and principles of Smart Materials
3. synthesis, sensing and actuation of Piezoelectric Materials, Magneto strictive Materials, Shape Memory Alloys, Electroactive Polymers
4 synthesis, sensing and actuation of Ferrofluids and Magneto rheological Fluids, Soft Matter, Carbon Nanotubes and Carbon nanostructures, Thermoelectric Materials
5. Classify and select Smart Materials for Energy Applications: Materials used for energy storage
6 Classify and select Composite Materials, Nano Composite Materials

Module	Contents	Hours
1	**Introduction to Smart Materials:** Overview of the different types of Smart Materials, Smart materials used in structures, smart material for sensors, actuators controls, memory and energy storage and their inter-relationships, concept of High bandwidth- low strain generating materials (HBLS), and Low Bandwidth High Strain Generating Materials (LBHS), Nano Composite Materials	**07**
2	**Important Concepts of Smart Materials:** artificial skins, artificial muscles, biomimetic materials, materials with tuneable responses, non-linear properties, self-healing materials, adaptive structures, self-replicating materials/structures, self-assembly, inch worm devices, hysteresis, integrated sensing and actuation	**08**
3	**Overview of the following materials with focus on synthesis, constitutive/governing relationships, strengths and weaknesses, and applications (both sensing and actuation etc)** 1. Piezoelectric Materials 2. Magneto strictive Materials 3. Shape Memory Alloys 4. Electroactive Polymers	**06**
4	**Overview of the following materials with focus on synthesis, strengths and weaknesses, and applications** 1. Ferrofluids and Magneto rheological Fluids and applications in dampers 2. Soft Matter and its applications as smart skins, smart textiles etc 3. Carbon Nanotubes and Carbon nanostructures and its applications 4. Thermoelectric Materials and Peltier devices	**06**

5	**Smart Materials for Energy Applications:** Materials used for energy storage, Hydrogen Storage Materials, Energy harvesting, Energy scavenging from vibrations	**06**
6	**Manufacturing techniques for smart materials:** micromanufacturing, high resolution lithography, LIGA process, Generative manufacturing processes such as STL, SLS, SPB, BPM, LOM, SGC, FDM, BIS, BPM, Self-assembly process, Ion beam processes,	**06**

Assessment:
Internal Assessment for 20 marks: Consisting of Two Compulsory Class Tests.
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.
1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved

References:

1. M.V. Gandhi and B.S. Thompson, "Smart Materials and Structures", Chapman & Hall, London; New York, 1992 (ISBN: 0412370107)
2. Mel Scwartz, "Encyclopedia of Smart Materials Vol. I and II", John Wiley & Sons
3. SenolUtku, "Theory of Adaptive Structures : Incorporating Intelligence into Engineered Products", CRC Press (1998), ISBN: 9780849374319
4. A.V. Srinivasan, "Smart Structures: Analysis and Design", Cambridge University Press,Cambridge; New York, 2001 (ISBN: 0521650267)
5. G. Gautschi, "Piezoelectric Sensorics: Force, Strain, Pressure, Acceleration and Acoustic Emission Sensors, Materials and Amplifiers", Springer, Berlin; New York, 2002 (ISBN:3540422595)
7. K. Uchino, "Piezoelectric Actuators and Ultrasonic Motors", Kluwer Academic Publishers, Boston, 1997 (ISBN: 0792398114)
8. G. Engdahl, "Handbook of Giant Magneto strictive Materials", Academic Press, San Diego, Calif.; London, 2000 (ISBN: 012238640X)
9. K. Otsuka and C.M. Wayman, "Shape Memory Materials", Cambridge University Press, Cambridge; New York, 1998 (ISBN: 052144487X)
10. Eric Udd, "Fibre Optic Sensors: An Introduction for Engineers and Scientists", John Wiley & Sons, New York, 1991 (ISBN: 0471830070)
11. André Preumont, "Vibration Control of Active Structures: An Introduction", 2nd Edition, Kluwer Academic Publishers, Dordrecht; Boston, 2002 (ISBN: 1402004966)
12. HojjatAdeli, "Control, Optimization, and Smart Structures: High-Performance Bridges and Buildings of the Future", John Wiley, New York, 1999 (ISBN: 047135094X)
13. T.T. Soong, "Passive Energy Dissipation Systems in Structural Engineering", Wiley, Chichester; New York, 1997 (ISBN: 0471968218)

14. V.K. Wadhawan, Smart Structures: Blurring the Distinction Between the Living and Non-living , Oxford University Press, Oxford (2007) ISBN: 9780199229178
15. H.T. Banks, R.C. Smith and Y Wang, “Smart Structures: Modelling, Estimation and Control”, Wiley, New York (1996)
16. Shape Memory Alloys, (ed) D.C. Lagoudas, Springer Science (2008)
17. S.K. Ghosh , “Self-healing Materials: Fundamentals, Design Strategies and Applications, Wiley-VCH Verlag GmbH and Co. (2009), ISBN: 978-3-527-31829-2
18. Kwang J KIm and Satoshi Tadokore, “Electroactive Polymers for Robotic Applications: Artificial Muscles and Sensors”, Springer-Verlag, London (2007) ISBN: 9781846283710
19. S Priya and D J Inman, “Energy Harvesting Technologies”, Springer-Verlag (2008) ISBN: 978-0-387-76463-4
20. MoriakiWakaki, “Optical Materials and Applications”, CRC Press (2012) ISBN: 9781315221403
21. S.S. Ray and M Bousmina, “Polymer Nanocomposites and their Applications”, American Scientific Publishers (2008)