INDIAN INSTITUTE OF INFORMATION TECHNOLOGY
DESIGN AND MANUFACTURING (IIITDM) KANCHEEPURAM

INTRODUCTION OF NEW COURSE

<table>
<tr><td>Course Title</td><td>Inverse problems in Engineering</td><td>Course No
(to be assigned by Academic Cell)</td><td colspan="4"></td></tr>
<tr><td>Specialization</td><td>Mechanical Engineering</td><td>Structure (LTPC)</td><td>3</td><td>1</td><td>0</td><td>4</td></tr>
<tr><td>To be offered for</td><td>UG / PG</td><td>Status</td><td colspan="2">Core ☐</td><td colspan="2">Elective ▬</td></tr>
<tr><td>Faculty Proposing the course</td><td>Dr. Shubhankar Chakraborty</td><td>Type</td><td colspan="2">New ☐</td><td colspan="2">Modification ▬</td></tr>
<tr><td colspan="2">Recommendation from the DAC : 01-06-2021</td><td>Date of DAC</td><td colspan="2">01-06-2021</td><td colspan="2"></td></tr>
<tr><td colspan="2">External Experts(s):</td><td colspan="5">Prof. P.K.Das (IIT Kgp) ; Prof. S.P. Venkateshan</td></tr>
<tr><td>To take effect from</td><td>Dec 2021</td><td rowspan="2">Submitted for approval</td><td colspan="4" rowspan="2">46th Senate</td></tr>
<tr><td>Pre-requisite</td><td>Heat transfer and fluid mechanics</td></tr>
<tr><td>Learning Objectives</td><td colspan="6">The main objective of this course will be
• to make the students familiar to different real life ill-posed problems
• to learn different solution methodologies through a various field of engineering problems
• to develop Matlab or Python programming to use the methodologies to solve the problems.</td></tr>
<tr><td>Learning Outcomes</td><td colspan="6">The students will be able to
• understand different levels of ill-posed problems and their uniqueness.
• solve different ill-posed problem of different fields of mechanical engineering (heat transfer, fluid mechanics, dynamics, and manufacturing)
• develop their own Matlab or Python programming to solve inverse problems.</td></tr>
<tr><td>Contents of the course
(With approximate break up of hours)</td><td colspan="6">• Introduction: (L2+T0): Forward problem – inverse problem - Scope of inverse problems - Determination of unknown boundary conditions – material property etc, multi-parameter estimation
• Review of Mathematical Concepts: (L4+T2):Linear Algebra, Probability and Statistics, Vector Calculus
• Classical Methods (L15+T5) :Linear Regression, Singular Value Decomposition, Principal Component Analysis, Regularization method (The Regularized Form of Inverse Problems, The Construction of a Regularizing Operator, Regularization of the Inverse Problem Finite-dimensional Form, The Admissible Degree of Smoothing and Approximation Sampling Procedures, etc.), Conjugant gradient method (The Conjugate Gradient Method for parameter Estimation, The Conjugate Gradient Method with Adjoint Problem for Parameter Estimation, etc.), The Levenberg-Marquardt Method, Case studies: Tomography, Heat transfer, Deflection of beam
• Statistical Methods (L9+T3): Bayesian inference techniques, Maximum likelihood method, Case studies: Hot spot detection, Problems from solid mechanics
• Soft computing Method (L12+T4):Fast Forward model, Neural network (Multilayer Feedforward Neural networks with Sigmoidal activation functions, Backpropagation Algorithm, Representational abilities of feedforward networks), GA with Matlab, Case studies: Hot spot detection, Problems from solid mechanics</td></tr>
<tr><td>Text Books</td><td colspan="6">1. Ozisik, M. N. Inverse heat transfer: fundamentals and applications. CRC Press, 2000.
2. Neto, F.D.M. and da Silva Neto, A.J., An introduction to inverse problems with applications. Springer Science & Business Media, 2012</td></tr>
<tr><td>Reference Books</td><td colspan="6">3. Alifanov, Oleg M., and Oleg M. Alifanov. Inverse heat transfer problems. Berlin: Springer-Verlag, 1994.
4. Beck, James V. Inverse heat conduction: Ill-posed problems. James Beck, 1985.
5. Orlande, Helcio RB, et al., eds. Thermal measurements and inverse techniques. CRC Press, 2011.</td></tr>
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