<table>
<tr><td>Course Title</td><td>Nonlinear Dynamical Systems and Chaos</td><td>Course Code</td><td colspan="4">PH****</td></tr>
<tr><td>Dept./ Specialization</td><td>SH (Physics)</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>Tapas Sil</td><td>Type</td><td colspan="2">New ▬</td><td colspan="2">Modification ▭</td></tr>
<tr><td colspan="2">Recommendation from the DAC</td><td>Date of DAC</td><td colspan="4"></td></tr>
<tr><td>External Expert(s)</td><td colspan="6"></td></tr>
<tr><td>Pre-requisite</td><td>Knowledge of ordinary differential equations and linear algebra</td><td colspan="3">Submitted for approval</td><td></td></tr>
<tr><td>Learning Objectives</td><td colspan="6">This course introduces fundamental concepts of dynamical systems, dynamical flows, non-linearity and chaos.</td></tr>
<tr><td>Learning Outcomes</td><td colspan="6">Students will be able to
analyze the behavior of dynamical systems (e.g. find periodic orbits and assess their stability, draw phase portraits, etc.).
apply the techniques of nonlinear dynamics to physical processes
analyze changes (i.e. bifurcations) to dynamical systems as system parameters are varied,
analyze various chaotic applications in real-life systems, say engineering and biomedical applications,</td></tr>
<tr><td>Contents of the course
(With approximate break-up of hours for L/T/P)</td><td colspan="6">Introduction to Dynamical Systems: Overview, Examples and Discussion. (L1)
One-dimensional flows: Flows on the line, Fixed points and stability, Population growth, Linear stability analysis, Saddle-node, Transcritical and Pitchfork; bifurcations, Flow on the circle. (L12+T3)
Two-dimensional flows: Linear system; Phase Plane, Phase portraits, Phase space reconstruction; Fixed points and linearization, Limit cycles, Poincare-Bendixson theorem, Lienard systems, Bifurcations revisited: Saddle-node, Transcritical and Pitchfork bifurcations, Hopf bifurcations, Driven pendulum and Josephson, junction, Poincare maps, Global bifurcation of cycles, Coupled Oscillators. (L15+T5)
Chaos: Lorenz equations: Properties of Lorenz equation, Lorenz Map; One-dimensional map: Fixed points, Logistic map, Liapunov exponent, Fractals: Countable and Uncountable Sets, Cantor Set, Dimension of Self-Similar Fractals, Box dimension, Pointwise and Correlation Dimensions; Strange Attractors: Baker’s map, Henon map, Duffing oscillator – nonlinear resonance. (L15+T5)</td></tr>
<tr><td>Text Book</td><td colspan="6">Strogatz, S. “Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry, and Engineering”. CRC Press, 2020. ISBN: 9780738204536
Robert C. Hilborn, “Chaos and nonlinear dynamics: an introduction for scientists and engineers” Oxford Press University 2004</td></tr>
<tr><td>Reference Books</td><td colspan="6">M.W. Hirsch, S. Smale, R. L. Devaney, “Differential Equations, Dynamical Systems & An Introduction to Chaos”, Academic Press, 2012
Kathleen Alligood, Tim Sauer, J.A. Yorke,” CHAOS: An Introduction to Dynamical Systems” Springer, 2012
John H. Argyris, Gunter Faust, Maria Haase, “An exploration of dynamical systems and chaos: completely revised and enlarged second edition” Springer 2015</td></tr>
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