4. OBJECTIVES: Network science, an emerging field of scientific research, studies the structural properties and the dynamic behavior of (large-scale) complex networks. Due to the sheer size and the inherent complexity of these networks, techniques and methodologies from a variety of disciplines, including Computer science, Mathematics, Statistics, Physics, Sociology, need to be used in order to understand the patterns. This course introduces visualization and fundamental quantitative models, graph theoretic concepts, and algorithmic techniques for network analysis. Selected applications of these techniques will be included. EXPECTED OUTCOMES: Upon successful completion of this course, students are expected to demonstrate the ability to: (a) Understand the basic mathematical principles and analytic foundations of network science (b) Have a knowledge of quantitative approach to understand small and large-scale networks, (c) Use the R software for the analysis and visualization of network data. TOPICS and WEEKLY SCHEDULE: Weeks 1-2 (Jan 6– 17). Introduction; types of networks: social networks, information networks, technological networks, biological networks, affiliation networks; network data collection methods. Labs start in the second week with introduction to R and igraph library. Weeks 3-5 (Jan 20– Feb 7) Mathematical and graph-theoretic concepts: directed graphs, the adjacency matrix, acyclic directed networks, bipartite graphs, trees, degree, paths, geodesic paths. Weeks 6-9 (Feb 10 – Mar 6) Structural Characteristics and Measures of Networks: Degree centrality, eigenvalue centrality, Katz centrality, page rank, hubs and authorities, closeness centrality, betweenness centrality, cliques and components, clustering coefficient, local clustering, reciprocity, signed networks, similarity and correlation, Computer algorithms implementation in R. Weeks 10-11 (Mar 9 – Mar 20) Large-scale structure: Components, Small-world effects, Degree distributions, Power laws and scale-free networks, Community detection algorithms. Week 12-13 (Mar 23 – April 3) Network Models: Random graphs, Preferential attachment, BarabásiAlbert model, Simulation of network formation using these models.