

| GANPAT UNIVERSITY   |   |    |                 |    |                                     |                          |     |       |     |
|---|---|----|-----------------|----|-------------------------------------|--------------------------|-----|-------|-----|
| FACULTY OF ENGINEERING & TECHNOLOGY   |   |    |                 |    |                                     |                          |     |       |     |
| Programme   | Bachelor of Technology  |    |                 |    | Branch/Spec.                        | Mechatronics Engineering |     |       |     |
| Semester  | V   |    |                 |    | Version                             | 2.0.1.0                  |     |       |     |
| Effective from Academic Year  | 2017-18   |    |                 |    | Effective for the batch Admitted in | June 2015                |     |       |     |
| Subject code  | 2MC502  |    | Subject Name    |    | CONTROL ENGINEERING                 |                          |     |       |     |
| Teaching scheme   |   |    |                 |    | Examination scheme (Marks)          |                          |     |       |     |
| (Per week)  | Lecture(DT)   |    | Practical(Lab.) |    | Total                               | CE                       | SEE | Total |     |
|   | L   | TU | P               | TW |                                     |                          |     |       |     |
| Credit  | 3   | 0  | 1               | 0  | 4                                   | Theory                   | 40  | 60    | 100 |
| Hours   | 3   | 0  | 2               | 0  | 5                                   | Practical                | 25  | 25    | 50  |
| Pre-requisites:   |   |    |                 |    |                                     |                          |     |       |     |
| Learning Outcome:   |   |    |                 |    |                                     |                          |     |       |     |
| After learning this course, students should be able to:   |   |    |                 |    |                                     |                          |     |       |     |
| <ul style="list-style-type: none"> <li>• Develop dynamics model and build block diagram for any engineering control systems.</li> <li>• Analyze control system in time domain and frequency domain.</li> <li>• Determine stability and performance parameters.</li> <li>• Prepare and interpret Root Locus, Bode plots, Polar plots and Nyquist plots</li> <li>• Use of various DC and AC machines and variable speed drives in control systems.</li> </ul> |   |    |                 |    |                                     |                          |     |       |     |
| Theory syllabus   |   |    |                 |    |                                     |                          |     |       |     |
| Unit  | Content   |    |                 |    |                                     |                          |     | Hrs   |     |
| 1   | <b>Introduction to Control System:</b><br>Introduction to control system, important definitions, Open loop and closed loop control systems, Concept of feedback & feed forwarded systems, Advantages and disadvantages of both types of systems, Classification of control systems, Servomechanisms.  |    |                 |    |                                     |                          |     | 1     |     |
| 2   | <b>Mathematical Modeling of Physical systems and Dynamic models:</b><br>Definition, Laplace Transform, Laplace Transform of standard functions, Inverse Laplace Transform, Partial fraction method. Definition of Transform function, Impulse response and Transform functions, Poles & Zeros of Transfer function, Mathematical modeling of physical systems-physical model and mathematical model - modeling of mechanical systems – Translation motion and Rotational motion-Analogous electrical systems, Force voltage analogy, Force current analogy, Advantages of analogous systems, Dynamic modeling of systems and responses. |    |                 |    |                                     |                          |     | 4     |     |
| 3   | <b>Block Diagram and Signal flow graph:</b><br>Block diagram fundamentals, basic rules for block diagram reduction, Introduction to signal flow graph algebra, Node elimination in signal flow graph, Mason's Gain formula.   |    |                 |    |                                     |                          |     | 4     |     |
| 4   | <b>Time Domain Analysis:</b><br>Time domain specifications, Standard test inputs, Step, Ramp, Parabolic and Impulse response, rise time, delay time, overshoot, and Steady state error, Error Coefficients.   |    |                 |    |                                     |                          |     | 5     |     |
| 5   | <b>Stability Analysis of Control systems:</b><br>Characteristics equation of a control system, Location of roots of characteristics equation on s-plane and their effects on the response of the system, Routh-Hurwitz Stability Criterion, Special cases in RH Tabulation, Determination of the range of K for stable operation.   |    |                 |    |                                     |                          |     | 7     |     |

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|--|---|---|
| 6  | <b>Frequency Domain Analysis:</b><br>Sinusoidal response of linear control system, Magnitude and phase curve, Polar plot, Nyquist plot and stability criterion, Relative stability, margin and phase margin, Bode plots, determination of absolute and relative stability from Bode plot  | 7 |
| 7  | <b>Root Locus Plot:</b><br>Angle and Magnitude criterion for plotting root locus, General rules for plotting root locus, Prediction of system response from root locus plot, Effect of addition of pole or zero on root locus.  | 8 |
| 8  | <b>Motion Control</b><br><b>Electric motors and their Application:</b> DC machines, DC variable speed drives, DC servomotors, induction machines, AC variable speed drives, stepper motors, synchronous machines, brushless machines, switched reluctance motor, toroidal torque motor, and electrical variable speed drive characteristics.<br><b>Variable Speed drive</b><br>Introduction criteria of the drive, selection criteria of the drive, configuration of parameter, remote and local operation, Variable Frequency drive, study of different operation methods. | 9 |
| Practical content  |   |   |
| The Practical/term work shall be based on the topics mentioned above and will be defended by the candidates. |   |   |
| Text Books   |   |   |
| 1  | Nagrath and N. Gopal, "Control System Engineering", New age international Ltd Edition 3rd .   |   |
| 2  | Katsuhiko Ogata, "Modern Control Engineering", Prentice – Hall of India Edition 4th .   |   |
| Reference Books  |   |   |
| 1  | M. Gopal, "Control Systems - Principles and Design", Prentice Hall of India Edition 3rd .   |   |