Reg.No. \_\_\_\_\_\_\_\_\_\_\_\_



**UNIVERSITY**

(Karunya Institute of Technology & Sciences)

(Declared as Deemed-to-be University under Sec.3 of the UGC Act, 1956)

**End Semester Examination – Nov/Dec – 2016**

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|  |  | **Semester :** | **2016-17 ODD** |
| **Code :** | **15MA3015** | **Duration :** | **3hrs** |
| **Sub. Name :** | **Control Theory** | **Max. marks :** | **100** |

.**ANSWER ALL QUESTIONS (5 x 20 = 100 Marks)**

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| --- | --- | --- | --- | --- |
| **Q. No.** | **Sub Div.** | **Questions** | **Course**  **Outcome** | **Mark** |
| 1. | a. | Prove that the observed linear system ,  is observable on  if and only if the observability Grammian matrix is positive definite, where \* denotes the matrix transpose. | CO1 | 10 |
| b. | Show that the second order differential equation  with the observation  is observable on . | CO1 | 10 |
|  | | | | |
| 2. |  | State and prove a theorem for observability of non-linear system , . | CO1 | 20 |
| 3. | a. | Prove that the system  is controllable on  if and only if for each vector there is a control  which steers from  to  during . | CO2 | 8 |
| b. | Derive the desired control variable for the control harmonic oscillator which steers from to during the time interval . | CO2 | 12 |
|  | | | | |
| 4. |  | Suppose the system  is completely controllable and the continuous function is bounded locally in and satisfies the following condition  (i) uniformly in  (ii) for each , there exists a constant such that for every , , , we have . Then prove that the system  is completely controllable. | CO2 | 20 |
| 5. | a. | Let  be a fundamental matrix of  where  is a continuous  matrix on . Then  (i) Prove that the system  is stable if and only if there exists a constant  with .  (ii) Prove that the system  is asymptotically stable if and only if  as . | CO1 | 12 |
| b. | State and prove Gronwall’s inequality. |  | 8 |
|  | | | | |
| 6. | a. | State and prove the necessary condition for a nonlinear system  to be asymptotically stable. | CO1 | 10 |
|  | b. | Determine whether the solutions of the differential equations      are asymptotically stable. | CO1 | 10 |
| 7. | a. | Stabilize the system using the Bass method. (10) | CO1 | 10 |
|  | b. | Suppose that there are  matrices such that  and  are stability matrices. Then prove that the system is controllable. | CO1 | 10 |
|  | | | | |
| 8. | a. | Prove that the control problem  for the system  is solvable if and only if . | CO1 | 10 |
| b. | Verify the stabilizability of two identical mass spring system  . | CO1 | 10 |
|  | |  |  |  |
| 9. | a. | Find the optimal control from the controllable system ,  with the cost functional  where we assume that . | CO3 | 8 |
| b. | For the continuous nonlinear system  with quadratic performance criteria , the optimal control exists , where  is a positive constant and is given by  where  satisfies the Riccati equation and, . | CO3 | 12 |

ALL THE BEST

CO1 : Students will be able to understand the advanced concept in Control Theory

CO2 : Students are able to apply Controllability concept in their subjects

CO3 : Students are able to understand the applications of Controllability**.**