**Modern Control Theory**

**Project –I**

**Problem Statement:**

Consider the FCC model (nonlinear model) given in Balchen et al. (1992). The model has been simulated to get the dynamic variation of output by perturbing the system with an input signal (eg: IRS signal). {Input variables : 𝐹𝑎, 𝐹𝑠𝑐 and Output variables : 𝐶𝑟𝑐 , 𝑂𝑑, 𝑇𝑟𝑔 }. One set of results obtained, is attached in the mat file ‘DATA\_REQD.mat’. A function file for the model provided in the reference is also uploaded for simplicity. You are free to write your own codes for the same. Choose appropriate X0 and P0 and obtain the state estimates of this system by implementing Extended Kalman Filter for the specified time interval for the following two cases.

1. When there is only one measured output (‘Y\_measured\_case1’ in DATA\_REQD.mat)
2. When there are two measured outputs (‘Y\_measured\_case2’ in DATA\_REQD.mat)

Report your observations and discuss your understanding of the state estimation technique.

**General Instructions**

* The report has to be submitted in pdf or word format.
* Each group of students should upload only one submission. Mention name and roll number of each student clearly in your report.
* It should not be more than 5 A4 sized pages. Use font size of 11 pts.
* Submit all your codes along with the report separately.
* Upload in moodle as a zipped folder named ‘RollNum\_Proj1’ (eg. CH13M012\_Proj1)

**Files provided**

fcc\_parameters.m : contains the model parameter values

fcc\_fn\_to\_solve\_odemodel.m : is a function file where the model equations are defined. The process input is passed as a parameter. You may use codes of your own instead.

DATA\_REQD.mat : contains the inputs and the measurement data required for estimation.

**References:**

Balchen, Jens G., Dag Ljungquist, and Stig Strand. "State—space predictive control." *Chemical Engineering Science* 47.4 (1992): 787-807.