## Whom will the course benefit?

Faculty members and practicing scientists/engineers in the disciplines of Aerospace Engineering, Control and Instrumentation, Chemical Engineering, Electrical & Electronic Engineering, Mechanical Engineering, Systems and Control, Robotics etc.

## Course Objective:

To provide basic theoretical background on optimal control and state estimation topics (including examples and assignments) as well as to give a good exposure about a few selected research topics through discussion of recent publications.

## Course Contents:

- **Introduction and Motivation**
- **Static Optimization:** Unconstrained optimization; Optimization with equality and inequality constraints; Basic Philosophy of Numerical Optimization.
- **Calculus of Variations:** Concepts; Fixed-End Point Problem; First & second Variations; Free-End point problem; Connection to Optimal Control.
- **Linear Quadratic Regulator (LQT):** Finite & Infinite Time and Riccati equations; Extensions of LQR: With Cross-product term minimization, state rate minimization, etc.
- **Brief Review of Selected Numerical Techniques**: Classical Numerical Techniques to solve Two Point Boundary Value Problems: Shooting Method, Gradient Method & Quasi-Linearization.
- **Linear Quadratic Tracker (LQT):** Free & Fixed Endpoints; Robustness of LQR. LQR Solution via State Transition Approach. SDRE & θ-D Designs.
- **Pontryagin's Principle and Dynamic Programming**
- **Transcription Technique:** Classical Concepts, Pseudo-spectral Transcription; HJB equation and LQR.
- **Brief Exposure to Artificial Neural Networks**
- **Discrete-Time Optimal Control:** Regulator & Tracker; Discrete Riccati Equation; Approximate Dynamic Programming & Adaptive Critic Design; Dynamically Re-optimized SNAC (DR-SNAC) Design; SNAC for Artificial Pancreas Development.
- **Constrained Optimal Control**: Time Optimal Problem; Constrained Fuel Optimal Problem; Constrained Energy Optimal Problem.
- **Applications to Biomedical and Wind Energy**
- **Model Predictive Static Programming (MPSP)**: Basic Principle; Extensions of MPSP: P-MPSP, I-MPSP and G-MPSP; Applications of MPSP for Optimal Guidance of Aerospace Vehicles.
- **State Estimation:** An Overview; LQ Observer Design; Review of Probability Theory & Random Variables; Continuous-Discrete Kalman Filter; Extended Kalman Filter (EKF) ; Overview of Unscented Kalman Filter (UKF) & Particle Filter; Application of Kalman Filter in Selected Aerospace Problems.
- **Tutorial & Lab Demo:** MATLAB implementation of LQR Control; LQT Control; Pseudo-spectral Transcription; SNAC & DR-SNAC; Time & Fuel Optimal Closed Loop Control via SIMULINK; Kalman Filter Design.

## Faculty:

**Radhakant Padhi**, Professor, Indian Institute of Science.

**D. S. Naidu**, Visiting Professor, Indian Institute of Science.

## Eligibility:

The course is meant for faculty of engineering colleges recognized by All India Council for Technical Education (AICTE), National Institutes of Technology (NIT's) and National Institute of Technical Teachers' Training & Research (NITTTRs) at free of cost. Selected teachers will also be paid TA at actual subject to the limit of Three tier AC train/bus fare by the shortest route from the place of work to Bengaluru and back. **However, the maximum TA payable is Rs.3000/-.** They will be provided with a daily allowance of **Rs.500/-** towards boarding and lodging as per the QIP rules, and will be supplied with the course materials. **The lodging charges will be Rs.300/- per day. Local participants will be paid DA @ Rs.150/- per day for 10 days.**

## Course Fee and Accommodation:

A few seats are available for non-sponsored (self-support) teachers, scientists from research labs, practicing engineers from industries and other interested persons, the fee for them will be as follows:

| | | |
|---|---|---|
| Academic Institutes, Govt. R&D Labs | : | **20,000 INR** |
| Private Industries | : | **30,000 INR** |

Single room **accommodation** is available on the Institute campus at the **Hoysala House** subject to availability. The participants have to request in advance along with the registration form for such accommodation. The lodging charges will be **Rs.1500/- per day** for Industry participants and **Rs.1000/- per day** for self-support college teachers and scientists from national R&D labs.


**CENTRE FOR CONTINUING EDUCATION**
**Indian Institute of Science,**
**Bengaluru –560 012**


# QIP Short Term Course On

# "Applied Optimal Control and State Estimation"

## 8-19 May 2017

## Registration Form

**(Please mail to reach before 15 April 2017)**

1. Name……..
2. Age:…….. Sex: Male/Female
3. Office address

   ……

   ……

   ……
4. Landline No. with STD code:……
5. Mobile No. ……
6. Email ID:…….
7. Academic Qualifications

| Degree | subject | year | University |
|---|---|---|---|
| Diploma/B.Sc./B.A…… | | | |
| B.E/B.Tech/M.Sc. …… | | | |
| M.E/M.Tech./M.Phil…… | | | |

Ph.D. Completed/Pursuing/Intend pursuing:……

Thesis title/Proposed Research Area:……..

……

8. Teaching Experience……(Years)
9. Industry Experience ……(Years)

10. Course taught/professional responsibilities……...

……

……

11. Accommodation required Yes / No

12. Self-support candidate:

Academic Institutes, Govt. R&D Labs: **20,000 INR**

Private Industries : **30,000 INR**

Demand Draft No…… dated……

I agree to abide by the rules of the QIP courses. If selected, I shall participate in the course for the entire duration.

Date:
Place: Signature

The applicant Mr/Ms…….....

……

from our institution will be permitted to attend the QIP Short Term Course on **"Applied Optimal Control and State Estimation"** to be held during **8-19 May 2017** at the Indian Institute of Science, Bengaluru, if selected. He/she will be granted necessary leave of absence.

It is certified that our college is recognized by AICTE Order No:……Date:……..

Place:

Date:

Signature of Head of the Department

Signature and Seal of the Principal of the Institution

**(Xerox copy of this form may also be used)**

Intending participants may use the attached application form or a xerox copy of the same. Applicants from AICTE recognized colleges, NIT's and NITTTRs are required to submit their applications sponsored by their colleges. Non-sponsored (self-support) applicants should send their application along with a **DD for the course fee** drawn in favor of **"Registrar, Indian Institute of Science, Bengaluru -560012"** payable at Bengaluru. The course fee will be **Rs.20,000** for participants from **academic institutions and government R&D labs** and **Rs.30,000** for participants from **other organizations**.

**Deadlines:**

Receiving completed applications: **15 April 2017**

Intimation of selection: **20 April 2017**

***Please mail the filled-in application form to:***

The Officer-in-charge
Centre for Continuing Education
Indian Institute of Science
Bengaluru - 560 012
Telephone: 080-23600911, 22932055
Email: so@cce.iisc.ernet.in/
office@cce.iisc.ernet.in

**To reach on or before: 15th April 2017**

# QIP Short Term Course On

# "Applied Optimal Control and State Estimation"

## 8-19 May 2017

**Coordinator**


**Prof. Radhakant Padhi**
**Dept. of Aerospace Engineering**


**Sponsored by**
**AICTE, NEW DELHI**


**Centre for Continuing Education**
**Indian Institute of Science**
**Bengaluru – 560 012**
**http://www.cce.iisc.ernet.in**