CE1.601

Earthquake Engineering

2022-23 Spring Semester

D Srinagesh

Outline

Outline

Title:	Earthquake Engineering
Credits:	3-1-0-4
When:	2023-22 Spring Semester
Faculty:	D Srinagesh
Teaching Asst:	Arpan Singh
Pre-Requisite:	Structural Dynamics

Objectives

- To impart the knowledge of Engineering Seismology Earthquake Engineering and its application to building design

- To understand earthquake behavior of various structural elements

Course Outline

- **Hazard**
  - *Seismo-tectonics, Seismology*
- **Behavior**
  - *Performance in Past EQs*
- **Analysis**
- **Design**
- **Detailing & Construction**
- **Assessment**
- **Strengthening**
- **Special Topics**
  - *Safety of Housing in India*

Vision

- **ZERO TOLERANCE to avoidable deaths**

– *National Disaster Management Guidelines*

- **Management of Earthquakes**

– *NDMA*

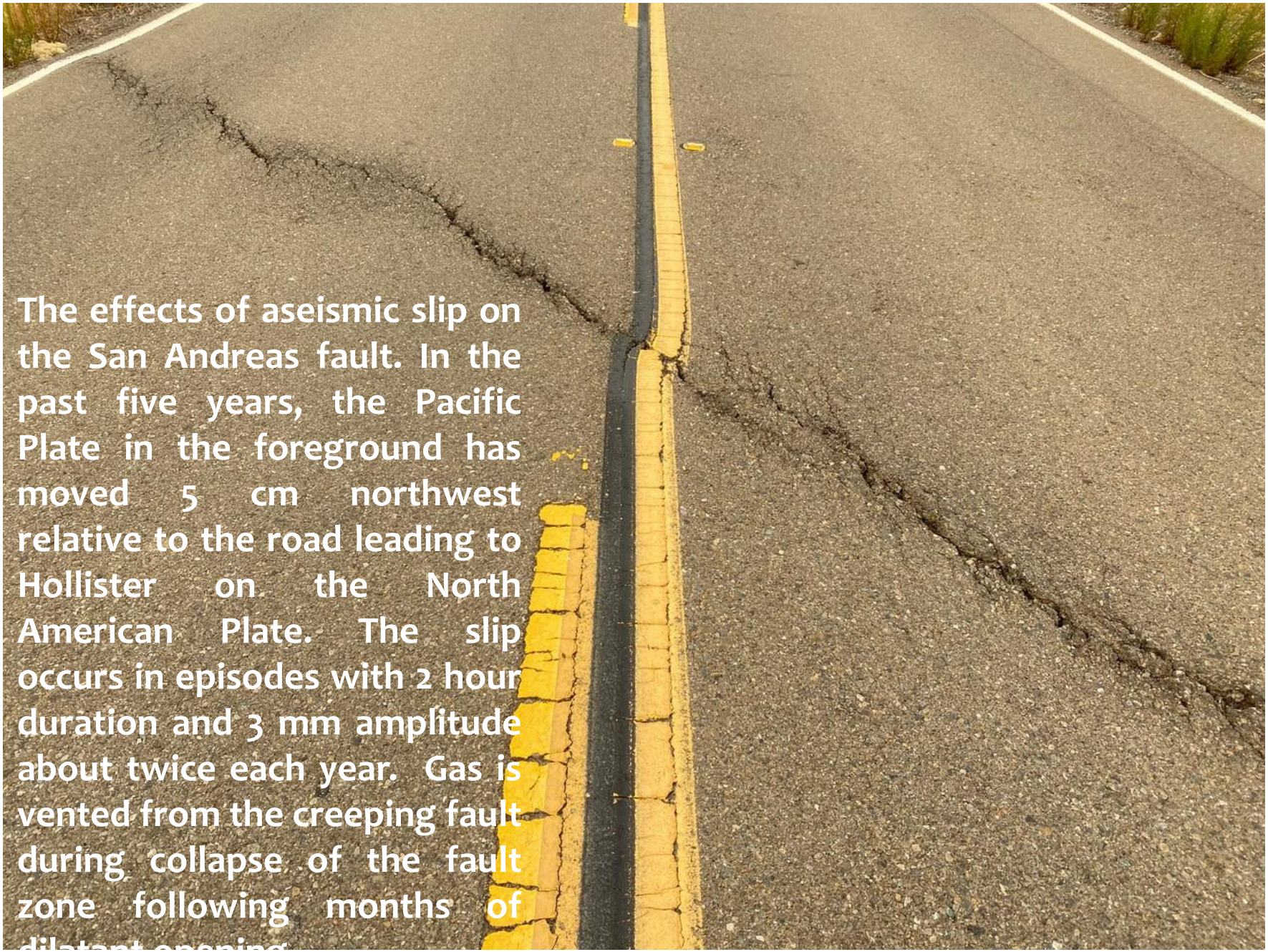
Course Topics

- Introduction to earthquake engineering & Seismology
  - ***Plate tectonics***
  - ***Earthquakes***
  - ***Seismic waves***
  - ***Magnitude and intensity***
  - ***Measurement of earthquakes***
- Characteristics of earthquakes
- Response of structures
- Concept of earthquake resistant design
- Seismic code Provisions for design of buildings
- Non-engineered constructions
- Post-earthquake evaluation of structures & Retrofitting
- Ductile detailing
- Special topics

Key concerns…

- **FAQs**
  - *Is an earthquake, a* **force** *or a* **displacement***?*
  - *Is it better to* **split** *a complex plan building into smaller rectangular units?*
  - *Is a* **flexible** *building more safe or a stiff building?*
  - *Does making the building* **stronger** *make it safer against earthquake effects?*
  - *Is* **taller** *building more ductile or a shorter building?*
  - *Is an* **RC** *building safer than a Steel building?*
  - *Is ductile detailing required in seismic zone* **II***?*
  - **Who** *is responsible for the safety of a building?*
  - *Does earthquake-resistant design* **cost** *more?*

Earthquake Fault is a geological feature associated with the earthquake generation. Weak zone or Fracture between two blocks of Faults allow the blocks to slip relative to each other



The effects of aseismic slip on the San Andreas fault. In the past five years, the Pacific Plate in the foreground has moved 5 cm northwest relative to the road leading to Hollister on the North American Plate. The slip occurs in episodes with 2 hour duration and 3 mm amplitude about twice each year. Gas is vented from the creeping fault during collapse of the fault zone following months of dilatant opening

Why do you need to Know about earthquakes

Earthquakes lead to damaging effects

Surface Faulting

Ground cracking

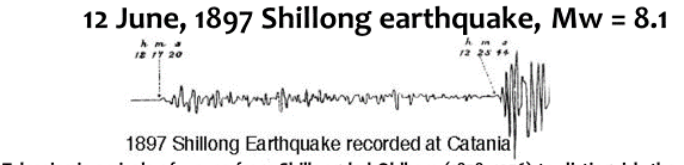
- **Earthquakes are characterized by Frequency and amplitude which is a function of seismo-tectonics and geology of the region**
- **Rate of the M (intensity of the earthquake)**
- **Focal Depth and epicentral distance**

Why do you need to Know about earthquakes

Earthquakes lead to damaging effects

Ground Subsidence

Liquefaction



Teleseismic arrivals of waves from Shillong led Oldham (1858–1936) to distinguish the three types of seismic waves and eventually to recognize from them the distinctive presence of the Earth's core

A sand vent near Rowmari photographed by LaTouche and reproduced by Oldham (1899)

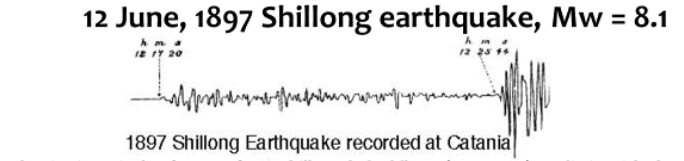
Why do you need to Know about earthquakes

Earthquakes lead to damaging effects such as ground cracking

Ground Subsidence

Vibratory effect of earthquakes due to Loose or compressible soils

Liquefaction



Teleseismic arrivals of waves from Shillong led Oldham (1858–1936) to distinguish the three types of seismic waves and eventually to recognize from them the distinctive presence of the Earth's core

A sand vent near Rowmari photographed by LaTouche and reproduced by Oldham (1899)

Fine saturated soils liquefy since they lose ability to carry loads

INDIRECT EFFECTS

Tsunami

Seiches

Fires

Japan Earthquake 1995

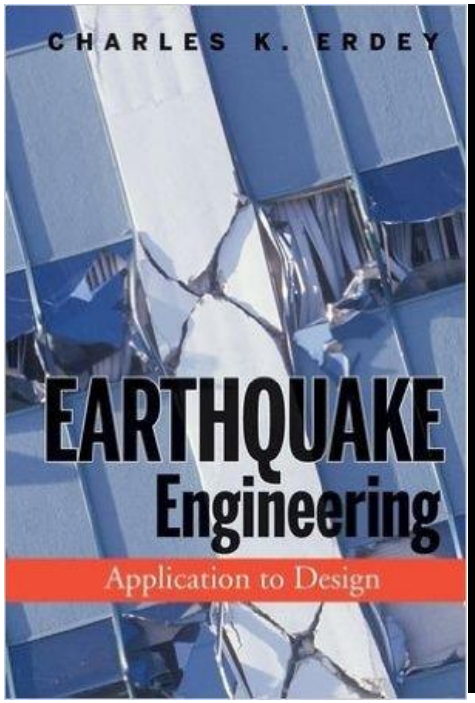
Smoke billows from buildings ablaze in Kobe in Hyogo Prefecture, Japan, after a powerful earthquake hit this western port city, Jan. 17, 1995. More than 6,000 people were killed by the pre-dawn quake. (AP Photo/Chiaki Tsukumo)

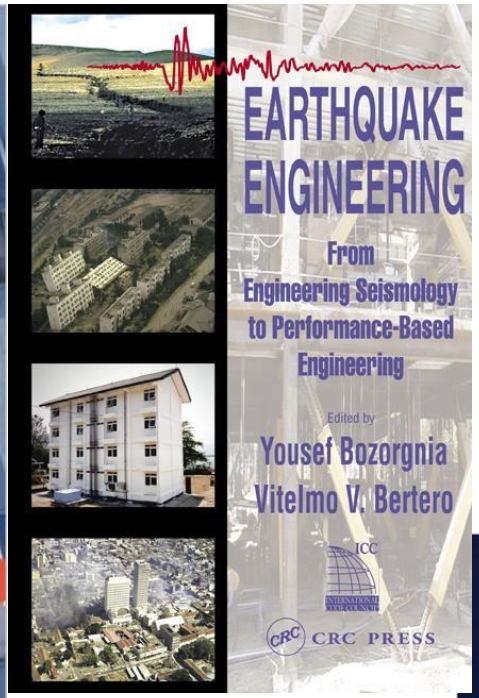
Chiaki Tsukumo

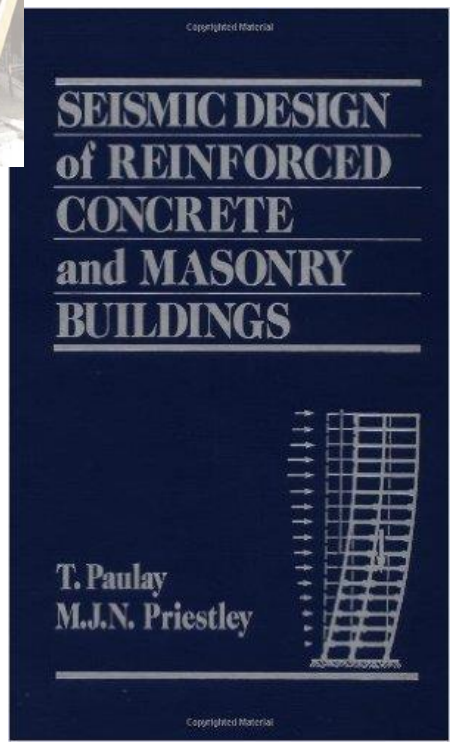
Earthquake load is generated by ground motion which is internal

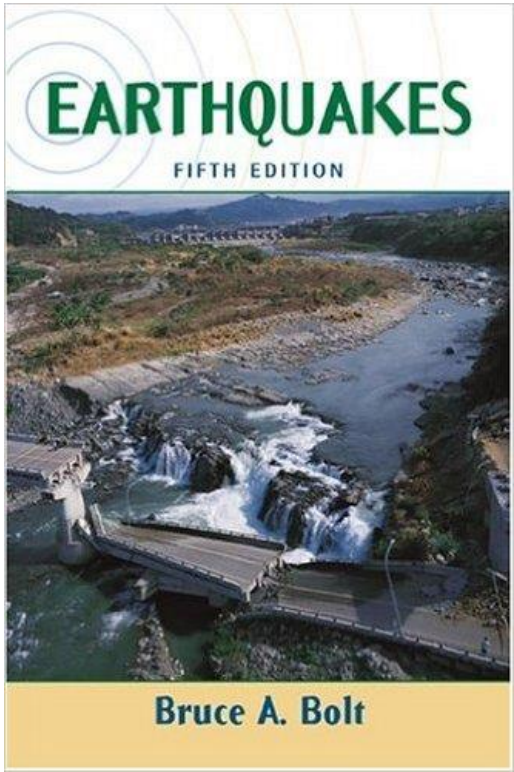
Hence, it is imperative to learn about earthquakes and their effects

Suggested Reading





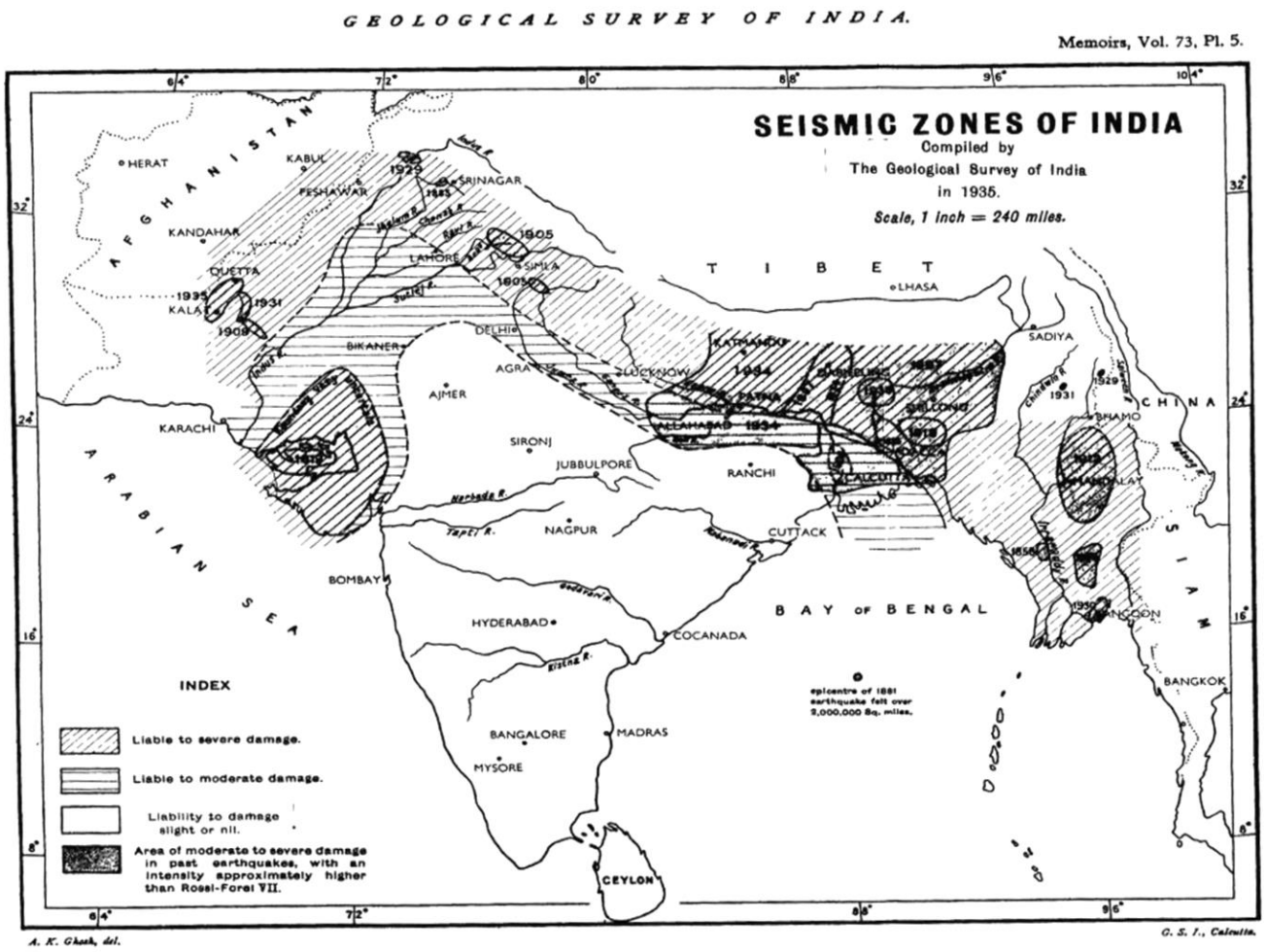




Standards & Reports

- Indian Standards
  - *IS 1893, IS 16700, IS 13920, IS 4326 and IS 456*
- American Standards
  - *ACI 318, FEMA 273, ATC40 Documents*
- European Standards
  - *Eurocode*
- Etc..

Seismic Zones of India



Timetable

Class Hours

- **Lectures**
  - *Monday* *14:00 – 15:25*
  - *Thursday* *14:00 – 15.25*

Evaluation

- **Credits**
  - *Assignments (4)* : ***20 %***
  - *Quizzes (2)* : ***20 %***
  - *Mid Exam (1)* : ***15 %***
  - *Projects (2)* : ***20 %***
  - *End-Semester Examination* : ***25 %***

Expectations

Attendance

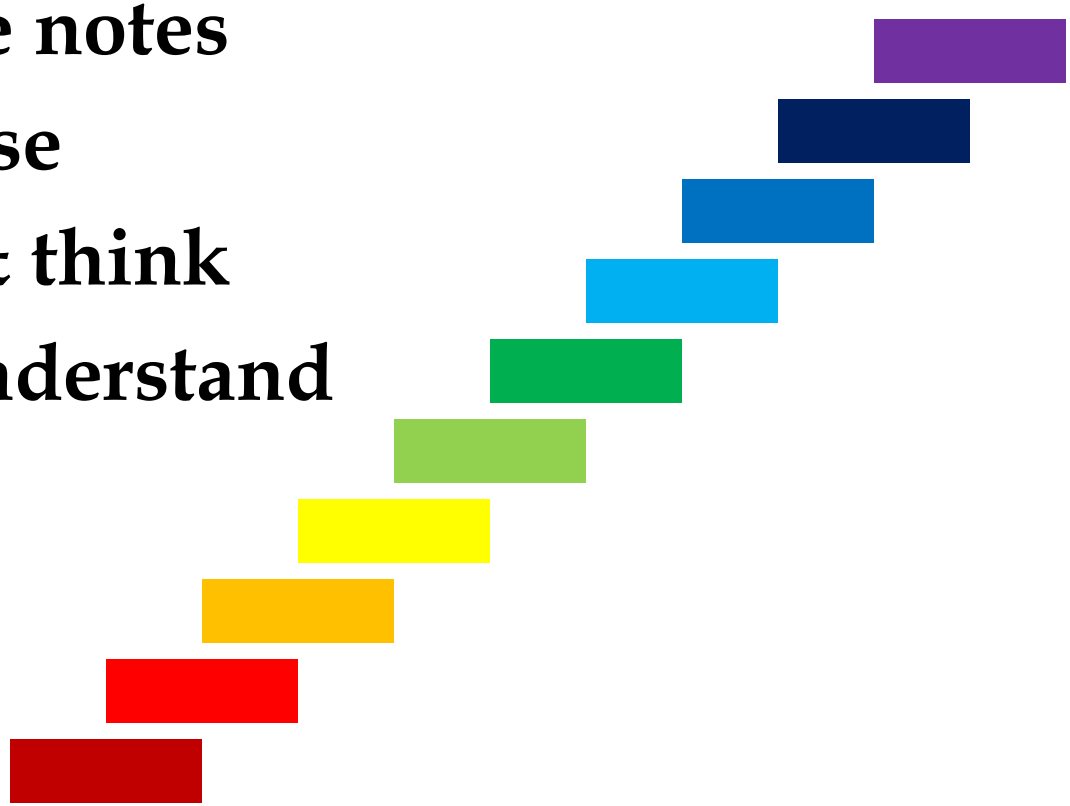
- **Institute requirement**
  - *85%*
  - *NO NEGOTIATIONS*

DD & PG Students

- **Be the best YOU can be**

  – *Learning habit*

    - **Listen & take notes**
    - **Read & Revise**
    - **Remember & think**
    - **Discuss & understand**



DD & PG Students

- **You are not alone**
  - *We are with you!!*

D Srinagesh

Guest Faculty
Earthquake Engineering Research Centre
IIIT Hyderabad

Mobile: 9440289075
eMail: srinagesh.davuluri@iiit.ac.in

Thank you…