

## Course outline

How does an NPTEL online course work?

Review of linear algebra and multivariable calculus

Smooth manifolds and Smooth maps

Tangent spaces

Tangent Spaces (Contd.)

Submanifolds

Vector Fields and Lie Groups

Flows of vector fields

Lie Brackets and Lie Algebras

Differential forms and Symmetric tensors.

Alternating tensors

Differential Forms

Orientation on manifolds.

Weekly Feedback forms

Video download

## An introduction to smooth manifolds.

The goal of this course is to introduce the student to the basics of smooth manifold theory. The course will start with a brief outline of the prerequisites from topology and multi-variable calculus.

After the introduction of differentiable manifolds, a large class of examples, including Lie groups, will be presented. The course will culminate with a proof of Stokes' theorem on manifolds.

**INTENDED AUDIENCE :** Masters and PhD students in mathematics, physics, robotics and control theory, information theory and climate sciences.

**PREREQUISITES :** Real analysis, linear algebra and multi-variable calculus, topology.

**INDUSTRY SUPPORT :** Nil



**Prof. Harish Seshadri**

IISc Bangalore

I work in Riemannian geometry (Einstein manifolds, Ricci flow, etc) and in questions related to invariant metrics in complex analysis.

## COURSE TYPE

Elective

## COURSE LEVEL

Postgraduate

## COURSE LAYOUT

**Week 1 :** Review of topology and multi-variable calculus

**Week 2 :** Definition and examples of smooth manifolds

**Week 3 :** Smooth maps between manifolds, submanifolds

**Week 4 :** Tangent spaces and vector fields

**Week 5 :** Lie brackets and Frobenius theorem

**Week 6 :** Lie groups and Lie algebras

**Week 7 :** Tensors and differential forms

**Week 8 :** Exterior derivative

**Week 9 :** Orientation

**Week 10 :** Manifolds with boundary

**Week 11 :** Integration on manifolds

**Week 12 :** Stokes Theorem

## BOOKS AND REFERENCES

Kumaresan: A course in differential geometry and Lie groups

John Lee: Introduction to smooth manifolds

Loring Tu: An introduction to manifolds

## CERTIFICATE

- The course is free to enroll and learn from. But if you want a certificate, you have to register and write the proctored exam conducted by us in person at any of the designated exam centres.
- The exam is optional for a fee of Rs 1000/- (Rupees one thousand only).
- **Date and Time of Exams: 25th April 2020**, Morning session 9am to 12 noon; Afternoon Session 2pm to 5pm.
- Registration url: Announcements will be made when the registration form is open for registrations.
- The online registration form has to be filled and the certification exam fee needs to be paid. More details will be made available when the exam registration form is published. If there are any changes, it will be mentioned then.
- Please check the form for more details on the cities where the exams will be held, the conditions you agree to when you fill the form etc.

### CRITERIA TO GET A CERTIFICATE:

- Average assignment score = 25% of average of best 8 assignments out of the total 12 assignments given in the course.
- Exam score = 75% of the proctored certification exam score out of 100
- Final score = Average assignment score + Exam score

### YOU WILL BE ELIGIBLE FOR A CERTIFICATE ONLY IF AVERAGE ASSIGNMENT SCORE $\geq 10/25$ AND EXAM SCORE $\geq 30/75$ .

- If one of the 2 criteria is not met, you will not get the certificate even if the Final score  $\geq 40/100$ .
- Certificate will have your name, photograph and the score in the final exam with the breakup. It will have the logos of NPTEL and IISc Bangalore. It will be e-verifiable at [nptel.ac.in/noc](http://nptel.ac.in/noc).
- Only the e-certificate will be made available. Hard copies will not be dispatched.