FOSSEE Semester Long Internship (Autumn) – 2025

On

Graphics & Animation (Using Open-Source Software)

Submitted by

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Under Guidance of

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Acknowledgement

I would like to express my gratitude to **Prof. Prabhu Ramachandran** (Principal Investigator FOSSEE, FOCAL, Department of Aerospace Engineering, IIT Bombay, Mumbai) whose vision of FOSSEE has enabled me to work on such a noble and creative endeavour, imparting the gift of comprehension to those that need it. I would like to thank my mentor **Mr. Khushalsingh K. Rajput**, (FOCAL Lead and Sr. Software Engineering. FOSSEE, IIT Bombay). If not for his quick witted insight and mind-boggling creative suggestion, my work would not have turned out to be as wonderful as it is now. He can understand the talent of students and give projects related to the student's talent. This may improve the quality of the project and gain a depth knowledge about the topics.

At last, I would like to take this opportunity to express my gratitude to the person who was instrumental for the conduction of this great programme. I show my greatest appreciation to **Prof. Prabhu Ramchandran** for tremendous support throughout the fellowship.

I perceive this opportunity as a first milestone in my career development. I will strive to use gained skills and knowledge in the best possible way and I will continue to improve, in order attain desired career objectives. I also hope to continue cooperation with all of you in future.

With Regards,

Rithika Pillai

Contents

1. Introduction

1.1. About the Fellowship

The FOSSEE (Free/Libre and Open Source Software for Education) project, an initiative by IIT Bombay under the National Mission on Education through ICT, Ministry of Education, Government of India, promotes the use of open-source tools in education and research. The Semester Long Internship (Autumn) 2025 provided an opportunity for students to contribute to educational resource creation using FOSS tools.

I was selected as a Graphics and Animation Developer under the FOCAL (Free and Open Source Creative Art Library) vertical and worked on developing Class 10 Mathematics animated tutorials using Synfig Studio and graphics using Inkscape.

1.2. Aim & Objectives

Aim:

To create a comprehensive series of 2D animated educational videos for Class 10 Mathematics, covering all 12 topics in the NCERT curriculum, to enhance student understanding through visual storytelling.

Objectives:

- To develop a detailed lesson plan and storyboard for 12 mathematics topics.
- To create engaging 2D animations using Synfig Studio and Inkscape.
- To script clear and concise narration aligned with animations.
- To produce high-quality educational videos suitable for classroom and self-paced learning.
- To promote the use of open-source animation tools in education.

1.3. Software Used

- **Synfig Studio:** 2D vector animation software for creating animations.
- **Inkscape**: Vector graphics editor for designing static assets and illustrations.
- **Blender:** Powerful, free, and open-source 3D computer graphics software suite used for creating animated films, visual effects, 3D models, motion graphics, video games, and interactive 3D applications.

2. About the Software

2.1. Synfig Studio

Synfig Studio is a free and open-source 2D vector-based animation software that enables the creation of high-quality animations with bitmap and vector artwork. It is widely used in the animation industry, education, and motion graphics due to its powerful features and non-destructive workflow.

Key Features Used:

- **Vector Tweening:** Automatic interpolation between keyframes for smooth motion.
- **Bone Rigging:** Used for character animation with inverse kinematics.
- **Layers and Blending Modes:** For complex compositing and visual effects.
- **Image Sequence Export:** Rendered animations as PNG sequences for further processing.
- **Mathematical Expression Support:** Allowed dynamic control of animation parameters.

Role in the Project:
Synfig Studio was the primary tool for animating mathematical concepts, character movements, graph plots, and geometric transformations. Its timeline-based keyframing system allowed precise control over animation timing.

2.2. Inkscape

Inkscape is a professional free and open-source vector graphics editor used for creating illustrations, icons, logos, diagrams, and complex artwork. It supports the SVG (Scalable Vector Graphics) format and is widely used in graphic design, education, and technical illustration.

Key Features Used:

- **Vector Drawing Tools:** Bezier curves, shapes, text, and path operations.
- **SVG Export:** High-quality scalable assets for animation.
- **Layers and Groups:** Organized design workflow.
- **Mathematical Diagram Support:** Created geometric shapes, graphs, and formula layouts.
- **Color Management and Gradients:** Enhanced visual appeal of assets.

Role in the Project:
Inkscape was used to design all static visual assets including character designs, background elements, mathematical symbols, graphs, title cards, and interface elements. These SVG assets were then imported into Synfig Studio for animation. Other than this for some of the topic instead of animation graphics were created using Inkscape.In addition to this, Inkscape was utilized to create graphics for some topics, as an alternative to animation.

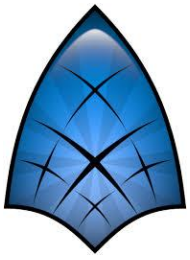
2.3. Blender

Blender is a free and open-source 3D creation suite that also includes a comprehensive video editing system. While primarily known for 3D modeling and animation, Blender's Video Sequence Editor (VSE) provides professional-grade video editing capabilities.

Key Features Used:

- **Video Sequence Editor (VSE):** For assembling image sequences into videos.
- **Audio Editing:** Integration of narration and background music tracks.
- **Transitions and Effects:** Crossfades, text overlays, and color correction.
- **Image Sequence Import:** Seamless import of PNG sequences from Synfig Studio.
- **Rendering Pipeline:** Final video export in multiple formats and codecs.

Role in the Project:
Blender served as the final compositing and editing platform. Image sequences exported from Synfig Studio were imported into Blender's VSE, synchronized with narration and background music, and rendered as final video files.

	Inkscape
	Blender
	Synfig

3. Project Workflow

3.1. Topic Selection and Research

- Selected all 12 Class 10 Mathematics topics from the NCERT syllabus.
- Studied each topic from NCERT textbooks, online resources, and existing educational content.
- Ensured conceptual accuracy and pedagogical clarity.
- Divided 6 topics for animation and rest 6 for graphics.

3.2. Scripting and Storyboarding

- Developed detailed narration scripts for each video.
- Created visual storyboards describing scenes, character actions, text overlays, and animations for video.
- Ensured alignment between narration and visual cues for video.
- Created a rough sketch to make the graphic more easy to understand.

3.3. Asset Creation in Inkscape for Animation

- Designed vector characters (Alex, Graphi, Coeffy) with consistent style.
- Created mathematical elements: number lines, coordinate planes, geometric shapes, graphs.
- Exported all assets as SVG files for use in Synfig Studio.

3.4. Animation Development in Synfig Studio

- Imported SVG assets from Inkscape if required.
- Applied bone rigging to characters for natural movement for topic Polynomial.
- Used keyframing to animate mathematical transformations and graph plotting if required.
- Added visual effects such as glows, fades, and highlights.

3.5. Image Sequence Export

- Rendered each animation scene as PNG image sequences from Synfig Studio.
- Maintained consistent naming conventions and frame rates (24 FPS).
- Organized sequences by topic and scene for easy import into Blender.

3.6. Video Compositing in Blender

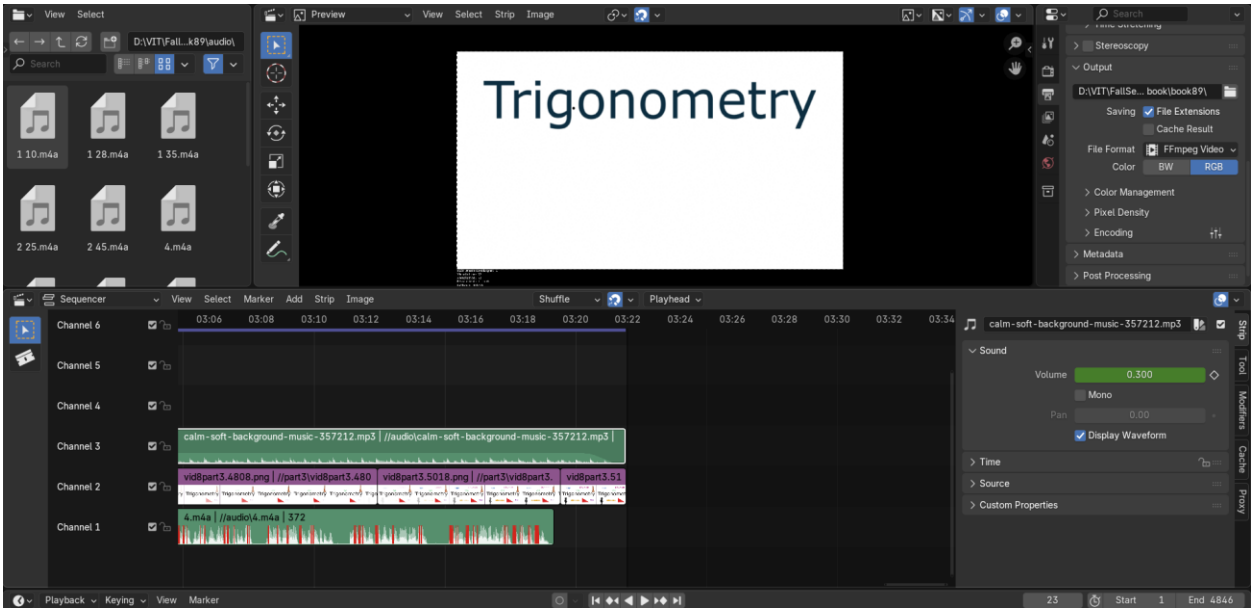
- Imported PNG image sequences into Blender's Video Sequence Editor.
- Filtered & arranged sequences on the timeline according to the storyboard.

3.7. Audio Integration

- Recorded and edited narration using Audacity.
- Imported audio files into Blender's VSE.
- Synchronized narration with visual elements on the timeline.
- Added background music tracks with appropriate volume mixing.
- Implemented audio fades and transitions.

3.8 Final Output

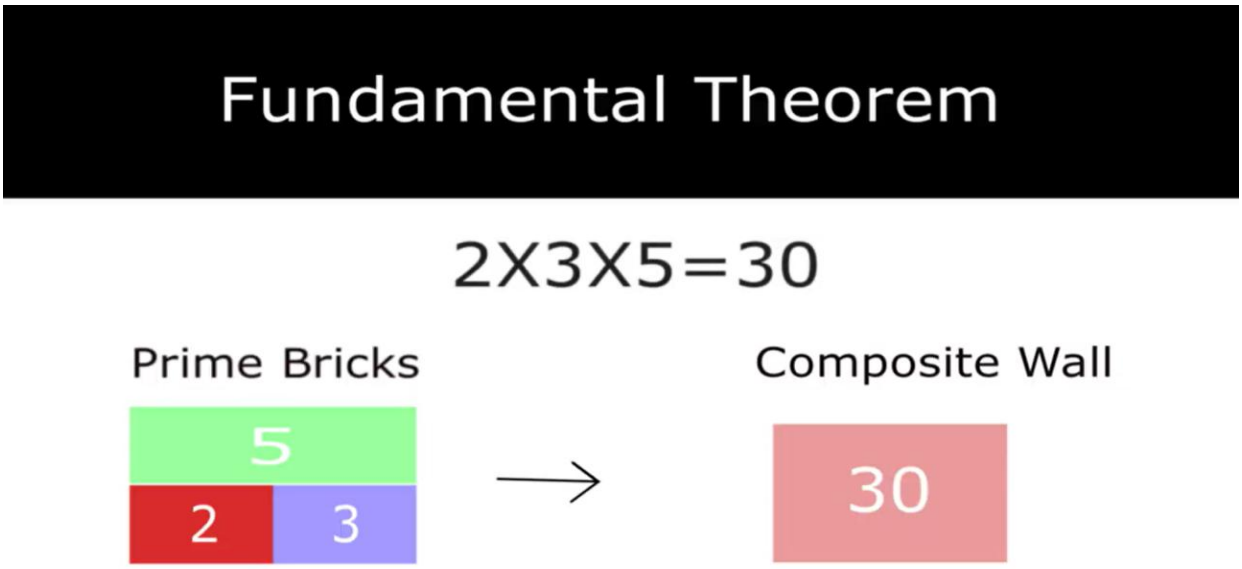
- Produced 6 animated videos and graphics for the rest of 6 topics.
- Exported final videos in MP4 format (24 FPS).
- Delivered source files (.sif, .svg, .blend), video files (.mp4), and scripts.



4. Project Outcomes

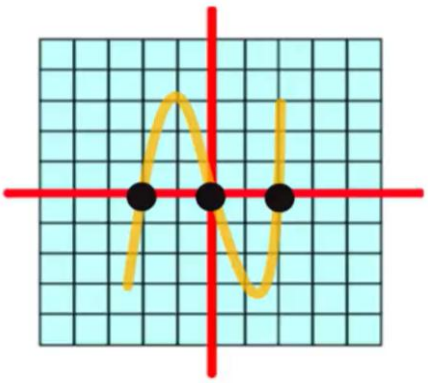
4.1. Topic 1-Real Numbers

An animation was created for this topic. The link to the animation can be found below:
https://drive.google.com/file/d/1JD8WWiFOTeBYdK89RYbdZh7dvuFlt7pZ/view?usp=sharing



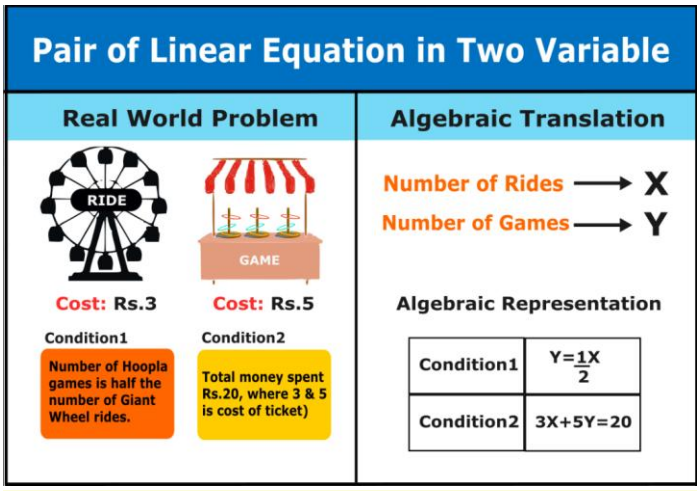
4.2. Topic 2-Polynomials

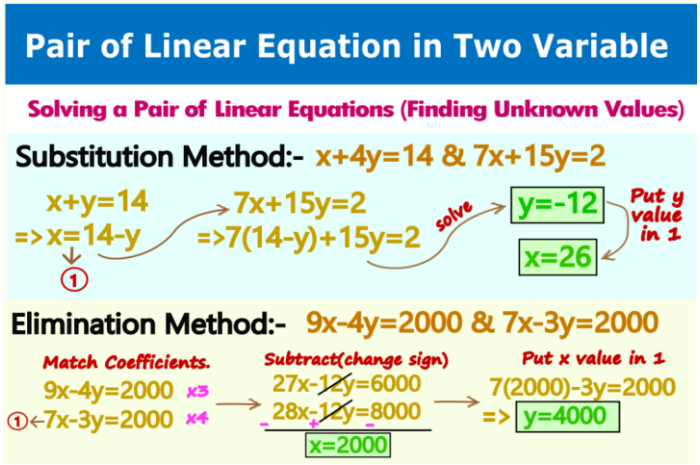
An animation was created for this topic. The link to the animation can be found below:
https://drive.google.com/file/d/13I_mi5dDdkoC05uDQE_VaaX5k1-M_Dnv/view?usp=sharing

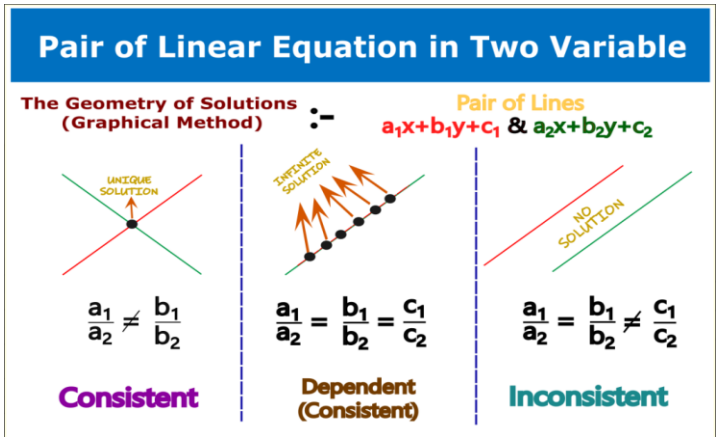


4.3. Topic 3-Pair of Linear Equation in Two Variable

The topic is backed up by three accompanying visuals, which you can check out below.

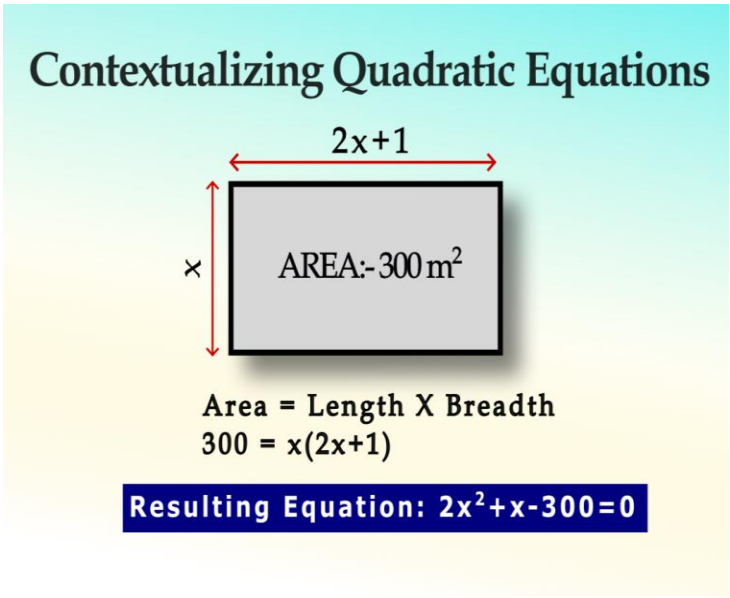


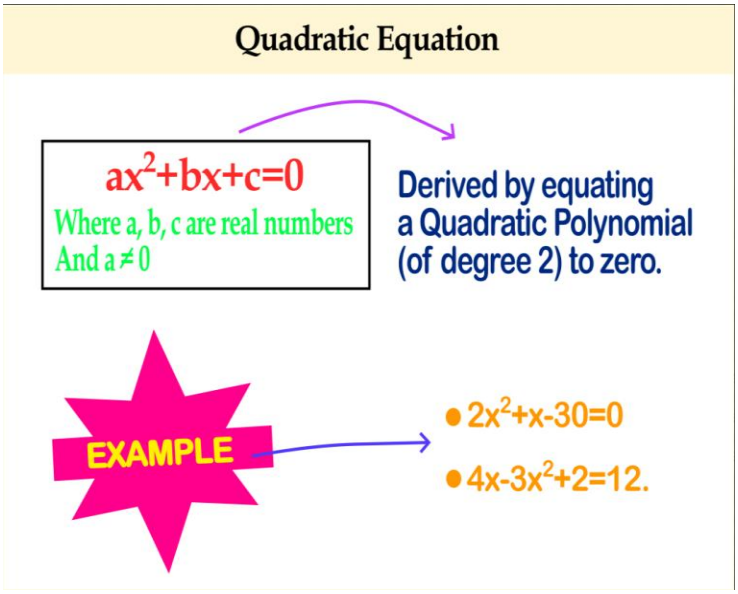


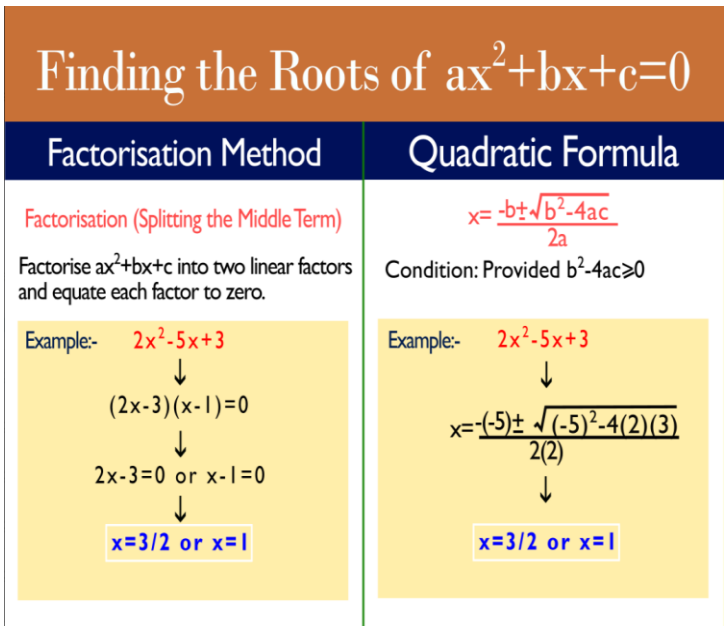


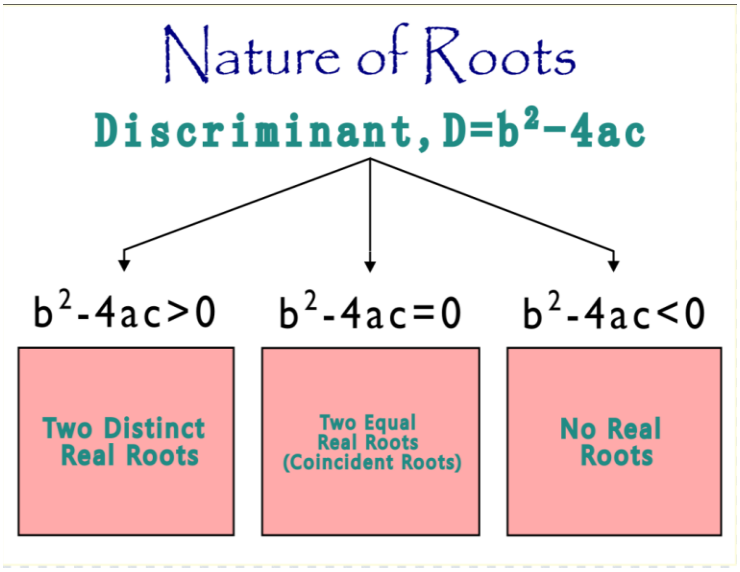
4.4. Topic 4-Quadratic Equation

The topic is backed up by four accompanying visuals, which you can check out below.



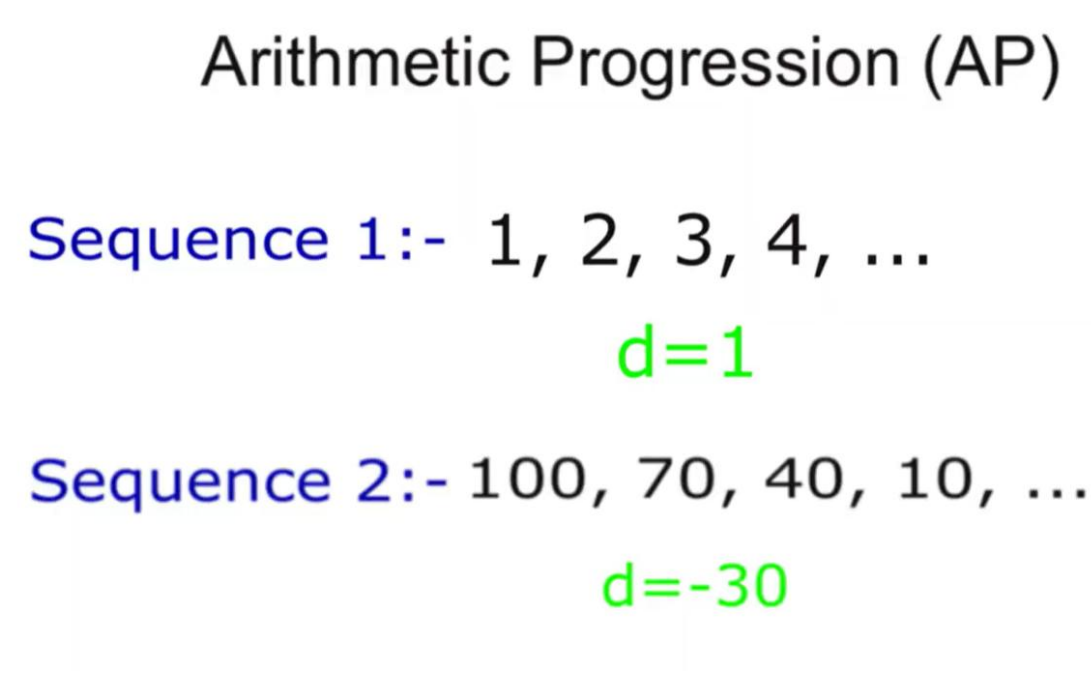






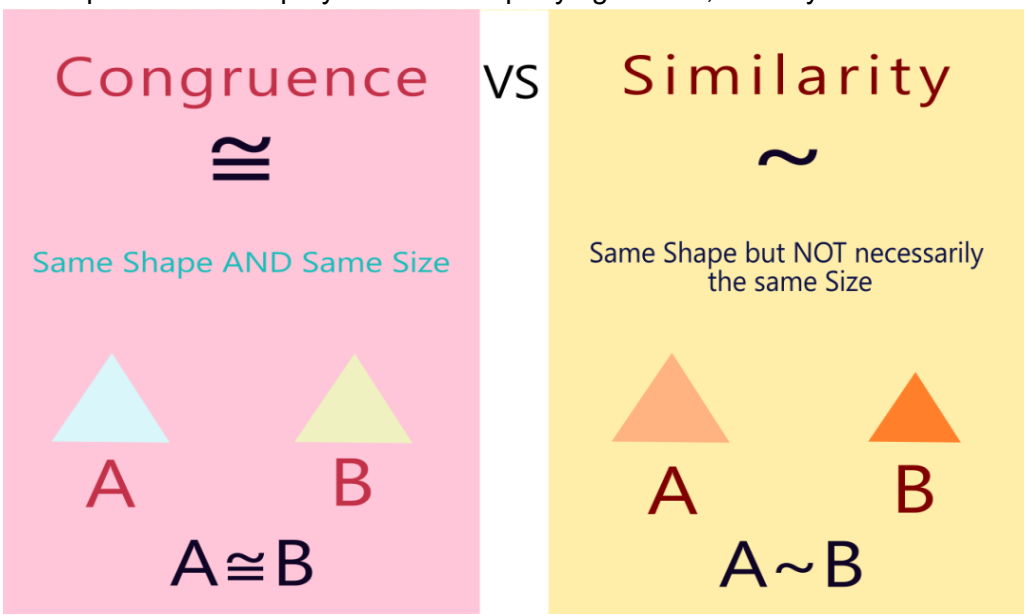
4.5. Topic 5-Arithmetic Progression

An animation was created for this topic. The link to the animation can be found below:
https://drive.google.com/file/d/1a1GIAbBL07_a55pDa9rb9YJ7nAVgPbII/view?usp=sharing

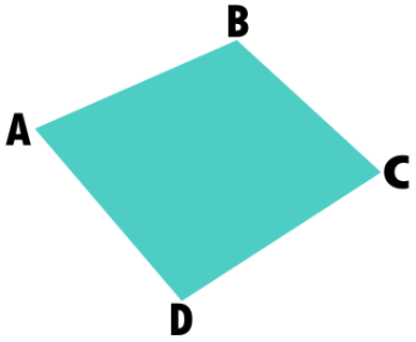


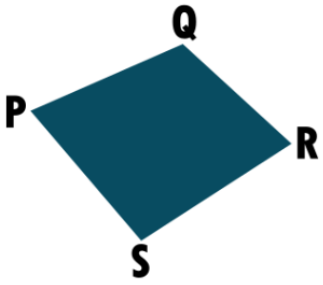
4.6. Topic 6-Triangles

The topic is backed up by three accompanying visuals, which you can check out below.



Conditions for Similarity (Polygons/Triangles)





Condition 1	Condition 2
Their corresponding angles are equal. $\angle A = \angle P$, $\angle B = \angle Q$, etc....	Their corresponding sides are in the same ratio (or proportion). $\frac{AB}{PQ} = \frac{BC}{QR} = \frac{CD}{RS} = \frac{DA}{SP}$

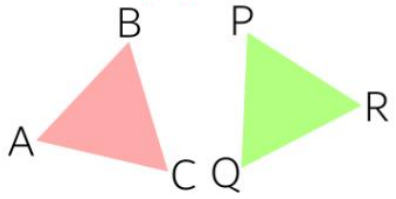
Triangle Similarity Criteria

AAA Similarity Criterion (or AA for two angles).

If corresponding angles are equal.

↓

Corresponding sides are proportional.



Given:- $\angle C = \angle R, \angle A = \angle Q, \angle B = \angle P$

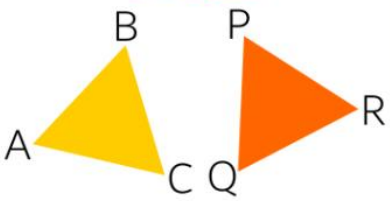
Hence:- $\frac{AC}{QR} = \frac{AB}{QP} = \frac{BC}{PR}$

SSS (Side-Side-Side)

If corresponding sides are proportional (in the same ratio).

↓

Corresponding angles are equal.



Given:- $\frac{AC}{QR} = \frac{AB}{QP} = \frac{BC}{PR}$

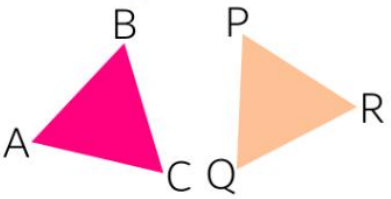
Hence:- $\angle C = \angle R, \angle A = \angle Q, \angle B = \angle P$

SAS (Side-Angle-Side)

If one angle is equal AND the sides including that angle are proportional.

↓

The two triangles are similar.



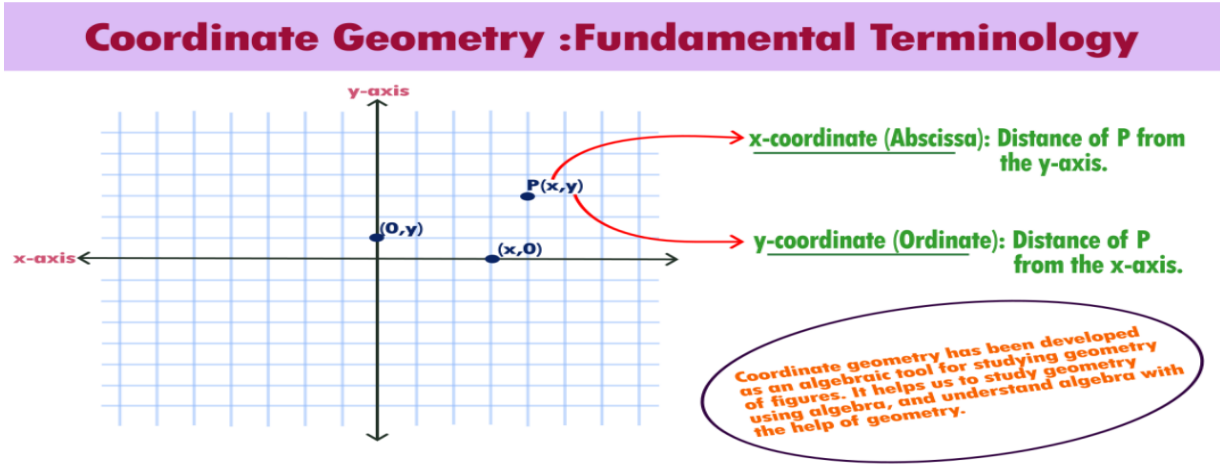
Given:- $\frac{AC}{QR} = \frac{AB}{QP}$ & $\angle B = \angle P$

Hence:- $\triangle ABC \sim \triangle PQR$

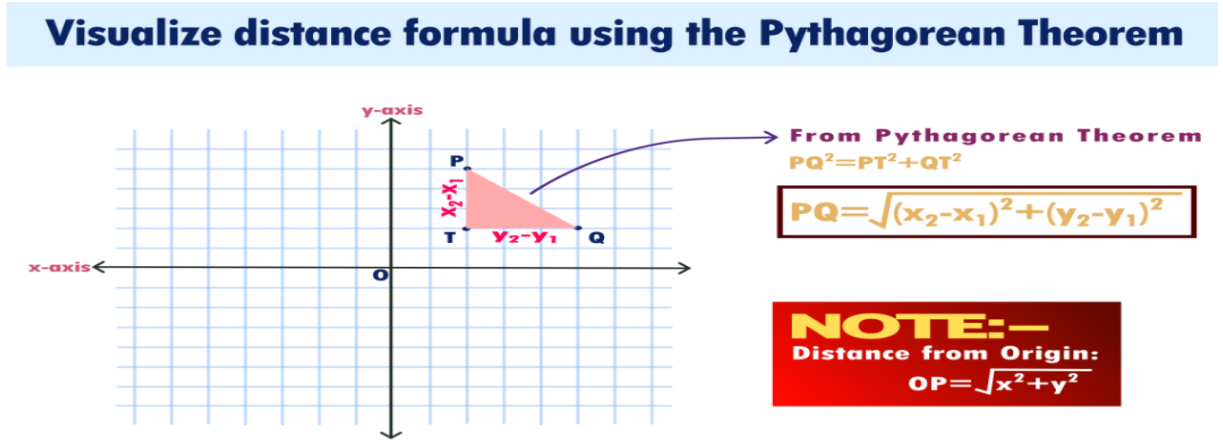
4.7. Topic 7-Coordinate Geometry

The topic is backed up by three accompanying visuals, which you can check out below.

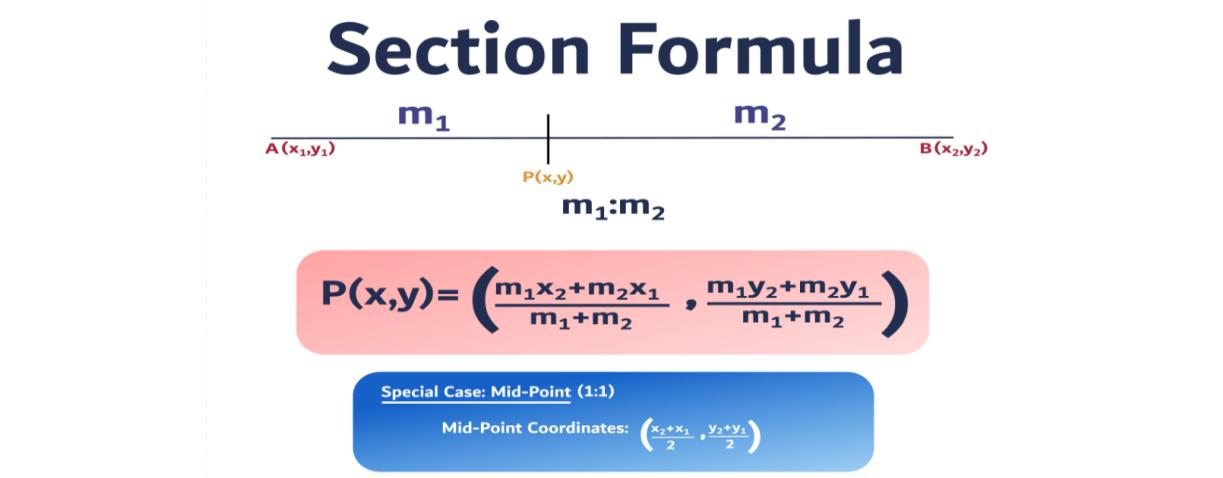
1.



2.

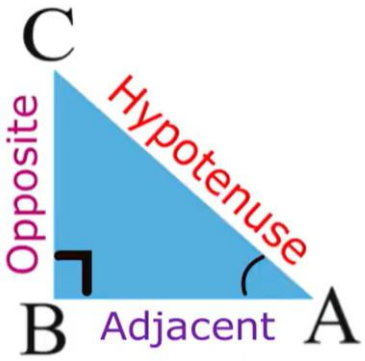


3.



4.8. Topic 8-Introduction to Trigonometry and its Application

An animation was created for this topic. The link to the animation can be found below:
https://drive.google.com/file/d/1sPlLGnWYiXREkhMTymsfAYV2NJRscCPA/view?usp=sharing



$$\sin\angle A = \frac{\text{side opposite to angle A}}{\text{Hypotenuse}} = \frac{BC}{AC}$$

$$\cos\angle A = \frac{\text{side adjacent to angle A}}{\text{Hypotenuse}} = \frac{AB}{AC}$$

$$\tan\angle A = \frac{\text{side opposite to angle A}}{\text{side adjacent to angle A}} = \frac{BC}{AB}$$

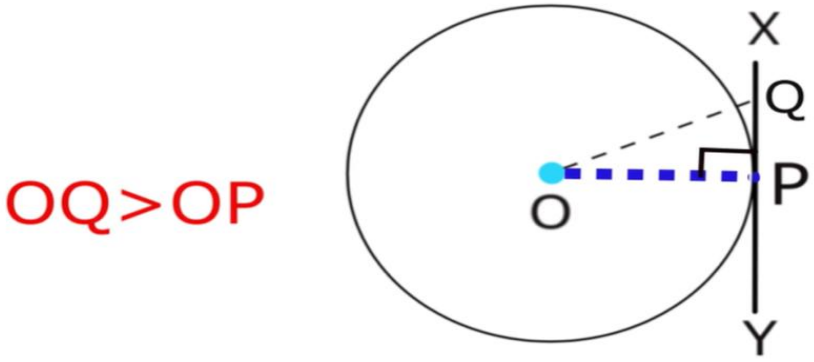
$$\text{cosec}\angle A = \frac{1}{\sin\angle A} = \frac{AC}{BC}$$

$$\sec\angle A = \frac{1}{\cos\angle A} = \frac{AC}{AB}$$

$$\cot\angle A = \frac{1}{\tan\angle A} = \frac{AB}{BC}$$

4.9. Topic 9-Circles and Area related to Circles

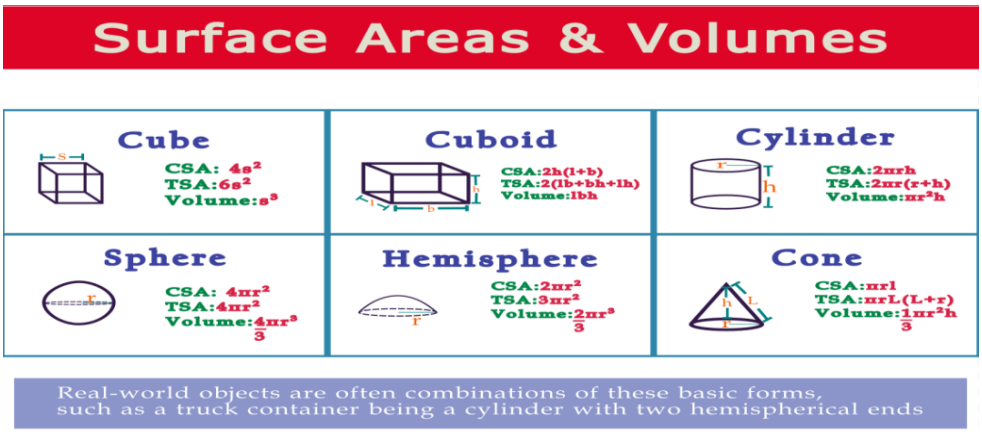
An animation was created for this topic. The link to the animation can be found below:
https://drive.google.com/file/d/1fHuDMWtvg4SOivCrKD3r-4ODeIiUycDF/view?usp=sharing



4.10. Topic 10-Surface Area and Volumes

The topic is backed up by three accompanying visuals, which you can check out below.

1.



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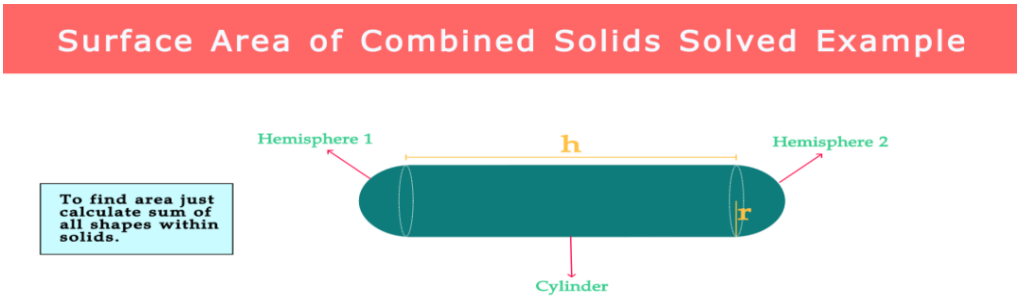
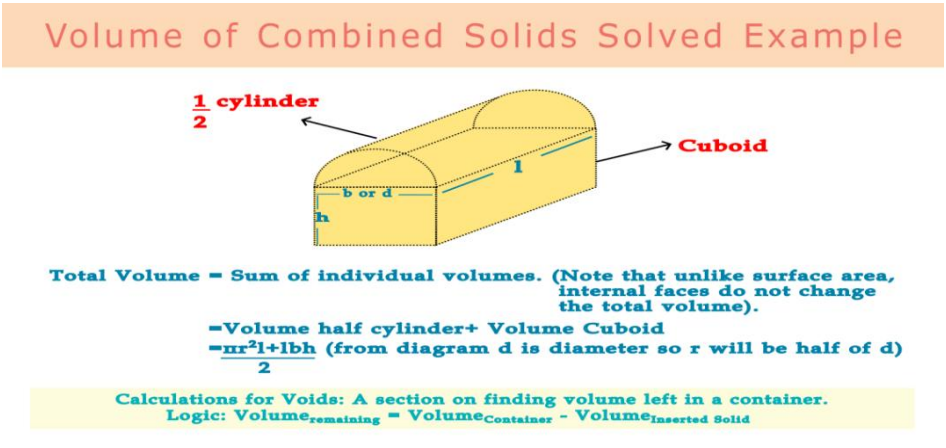


3.



4.11. Topic 11-Statistics

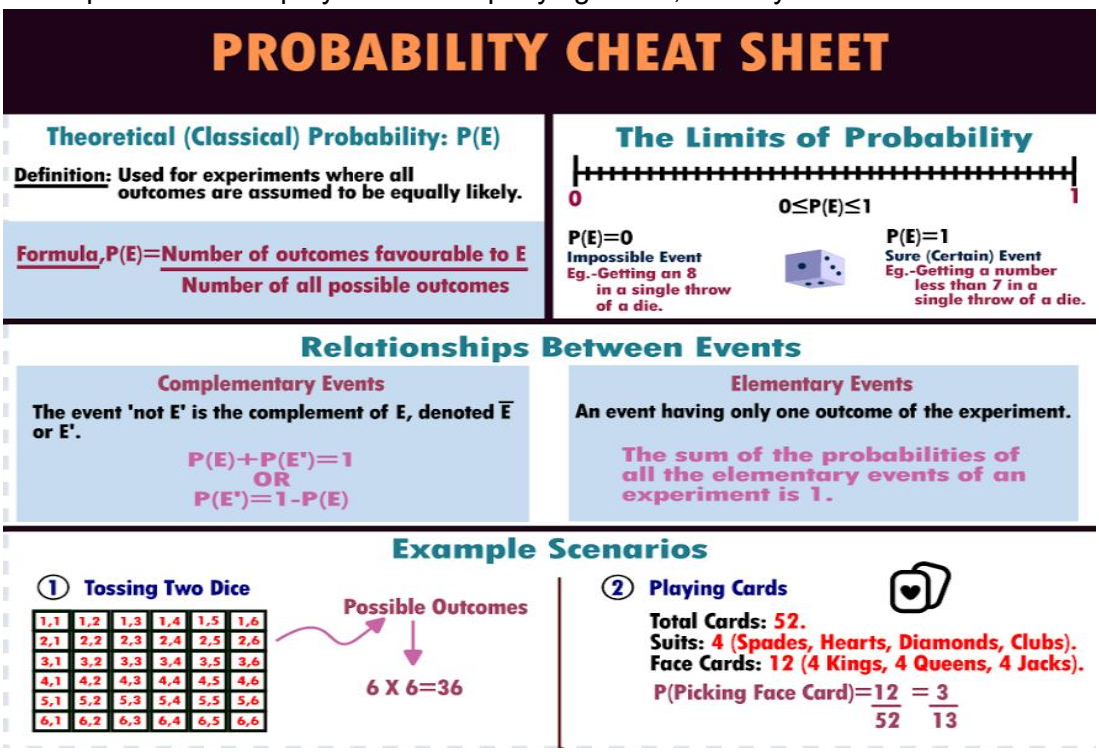
An animation was created for this topic. The link to the animation can be found below:
https://drive.google.com/file/d/1gohANyxVniZcPDP-kZJ8qnRhHlty6Ghb/view?usp=sharing

Class interval	Number of students (f_i)	Class mark (x_i)	$f_i x_i$
10 - 25	2	17.5	35.0
25 - 40	3	32.5	97.5
40 - 55	7	47.5	332.5
55 - 70	6	62.5	375.0
70 - 85	6	77.5	465.0
85 - 100	6	92.5	555.0
Total	$\Sigma f_i = 30$		$\Sigma f_i x_i = 1860.0$

$$\overline{x} = \frac{\Sigma f_i x_i}{\Sigma f_i}$$

4.12. Topic 12-Probability

The topic is backed up by one accompanying visual, which you can check out below.



5. Issues Faced and Solutions

- **Image Sequence Management:**
  - **Issue:** Large number of PNG files (thousands per video) causing organizational challenges.
  - **Solution:** Implemented structured folder hierarchy and naming conventions and filtered some of the images.
- **Frame Rate Consistency:**
  - **Issue:** Synfig Studio and Blender frame rate settings mismatches causing timing issues.
  - **Solution:** Standardized on 24 FPS across all software and verified settings before export/import.
- **Audio-Visual Synchronization:**
  - **Issue:** Narration not aligning perfectly with visual cues.
  - **Solution:** Used Blender's frame-by-frame scrubbing and audio waveform visualization for precise alignment.
- **Performance:**
  - **Issue:** Multiple elements causing synfig to crash.
  - **Solution:** Divided animation into multiple parts.

6. Future Plans and Follow-ups

- **Expand Series:** Develop animations for Class 9 and Class 11–12 Mathematics.
- **Multilingual Support:** Add voiceovers in regional languages.
- **Interactive Content:** Create quiz-based interactive videos using open-source platforms.
- **Community Contribution:** Share source files on FOSSEE platforms for educators to modify and reuse.

This has been a big learning opportunity in my life. Since I am an aspiring UI/UX Designer , I plan to combine the skills I have learned in the fellowship with my future goals and help the society.I have also learned to collaborate,and communicate effectively which helps in personality development. I see multiple possibilities from this.

I am always happy to join hands and work for the FOSSEE project in the future. I admire the FOSSEE team as well as their goal.

7. Reference

- NCERT Class 10 Mathematics Textbook
- Synfig Studio Documentation: https://synfig.org/
- Inkscape Documentation: https://inkscape.org/
- Blender Documentation: https://docs.blender.org/
- FOSSEE Project: https://fossee.in/
- Spoken Tutorial Project: https://spoken-tutorial.org/
- Google, YouTube, and educational portals for visual inspiration and pedagogical references.