

# SHORT COURSE ON GEOLOGY OF SINGAPORE & ROCK CAVERN DEVELOPMENT



NANYANG  
TECHNOLOGICAL  
UNIVERSITY  
SINGAPORE



Society for Rock Mechanics  
& Engineering Geology  
(Singapore)

## Theme 1 - New Stratigraphic Framework for Geology of Singapore and Its Applications

Date: 28 August 2024, Wednesday

## Theme 2 - Planning and Development of Rock Cavern Facilities

Date : 2 & 3 September 2024, Monday & Tuesday

Venue: CEE Seminar Room B (N1-B1b-16) School of Civil and Environmental Engineering Nanyang Technological University, Singapore

Theme 1 : 6PDU  
Theme 2 : 14 PDU  
STU : TBA

## COURSE INSTRUCTORS



Er Kiefer Chiam



Dr Zhou Yingxin



Michael Goay



Dr Lee Young Zoo

## COURSE OUTLINE

Accelerated paces of urbanization and climate change require a comprehensive and timely understanding of geological conditions to ensure safe and efficient development of usable space and resources. This course will provide essential backgrounds for Geology of Singapore and rock cavern development, covering two main themes: the new stratigraphic framework for geology of Singapore and its applications, and the planning and development of rock cavern facilities.

Theme 1 will provide an overview of a new geological framework for Singapore, including geological investigations and 3D modeling to visualize geological data. It will also address the gaps in site investigations for underground works in rock as well as the design philosophy for TBM tunnelling in rock.

Rock caverns have been utilized since ancient times when our ancestor's sought protection in caves against harsh environments. Modern applications of rock caverns include defense, urban development, critical infrastructure, industrial and commercial facilities, as well as research and recreational spaces. Rock cavern facilities offer significant advantages in protection and security, safety, land use efficiency, energy efficiency, and cost savings compared to underground construction in soft ground.

Theme 2 will introduce the key aspects of planning, designing and constructing rock cavern facilities.

## REGISTRATION FEES

Category	GeoSS/ SRMEG / TUCSS members	Non-members
Theme 1 only	\$250	\$300
Theme 2 only	\$500	\$550
Theme 1 & 2	\$710	\$810

The fee includes teabreaks, lunches, and course materials. Please register via the link before **22 August 2024**. Please note that there is no refund of fees for cancellation.



REGISTER HERE



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## PROGRAMME - THEME 1

TIME	PROGRAMME FOR 28 AUGUST 2024	SPEAKER
8.30am	<b>Registration</b>	
9.00am	<b>Welcome Speech by Prof Wu Wei, SRMEG President</b>	
9.05am	<p><b>Overview of New Geological Framework for Singapore</b></p> <p>It will provide an overview of a new geological framework for Singapore, which categorizes the bedrock geology into different units. The new stratigraphic framework was developed based on the new findings gathered from field mapping works carried out both on land and offshore islands of Singapore, and detailed core logging of BCA's deep boreholes. The stratigraphy studies also include specialised laboratory testing such as rock petrographic analyses, geochemical testing and radiometric age dating of the rock samples. This presentation will cover the understanding of the geological features that may have a significant impact on rock properties in Singapore.</p>	Er Kiefer Chiam Mr. Michael Goay
10.05am	<b>Morning Teabreak</b>	
10.30am	<b>Overview of New Geological Framework for Singapore (continued)</b>	Er Kiefer Chiam Mr Michael Goay
11.30am	<p><b>Geological Investigation and 3D Modelling of Geological Data</b></p> <p>It will discuss the methods used in geological investigation and show how 3D modelling is used to visualize geological data. Case studies will be presented to illustrate the impact of geological investigation on project outcomes.</p>	
12.30pm	<b>Lunch</b>	
1.30pm	<p><b>Site Investigation for Underground Works in Rock</b></p> <p>Current site investigation and its interpretation are based on soil mechanics. It will elaborate the problem encountered in executing underground works in rock and suggest rock mechanics approach as a way forward</p>	Dr Lee Young Zoo
3.00pm	<b>Afternoon Teabreak</b>	
3.30pm	<p><b>Design Philosophy for TBM Tunnelling in Rock</b></p> <p>Current design practice of TBM tunnelling is based on soil mechanics. It will present the problems encountered and propose design method and philosophy for TBM tunnelling in rock.</p>	Dr Lee Young Zoo
5.00pm	<b>Q&amp;A session</b>	
5.30pm	<b>End of Theme 1 - New Stratigraphic Framework for Geology of Singapore and Its Applications</b>	

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## PROGRAMME FOR THEME 2 BY DR ZHOU YINGXIN

TIME	PROGRAMME FOR 2 SEP 2024
8.30am	<b>Registration</b>
9.00am	<b>Introduction to Cavern Space Use</b> Use of rock caverns with examples of different applications; Reasons and benefits of underground space and their roles in sustainable development.
9.45am	<b>Morning Teabreak</b>
10.15am	<b>Planning &amp; Design Considerations</b> Key engineering considerations in planning rock caverns; Processes and tools in planning and design; Aspects of space planning, architectural considerations, cost estimates, and construction planning.
12.15pm	<b>Lunch</b>
1.15pm	<b>Fundamental Rock Mechanics</b> Rock mechanics fundamentals, rock material properties, shear strengths and failure criteria, rock mass properties, Geological Strength Index (GSI), global strength of rock mass
3.15pm	<b>Afternoon Teabreak</b>
3.45pm	<b>Rock Mass Classification</b> Concepts of rock mass and rock material; Primary factors in rock mechanics and rock engineering; Description of rock joints; Effects of ground water and in-situ stress; Rock Mass Quality (Q) and its use in rock support design.
5.45pm	<b>Q&amp;A session</b>
6.15pm	<b>End of Theme 2 Day 1</b>

TIME	PROGRAMME FOR 3 SEP 2024
8.30am	<b>Registration</b>
9.00am	<b>Cavern Design and Construction</b> Failure modes and analysis; Rock support systems using rock bolts and shotcrete; Design of rock support & water control; Underground rock excavation, drill & blast method and blasting vibrations and their control.
10.00am	<b>Morning Teabreak</b>
10.30am	<b>Cavern Design and Construction (Contd)</b>
12.00pm	<b>Lunch</b>
1.00pm	<b>Health &amp; Safety Underground</b> Main health and safety hazards underground and principal causes of accidents; Strategies and best practices in planning and management of underground construction safety; Basic concepts, processes and tools in design for safety and system safety approach.
2.00pm	<b>Risk Management in Underground Construction</b> Fundamental concepts of risks within the context of underground construction; Sources of risks, key risk factors, and the relationship between geological risks and non-geological risks based on case studies of tunnel failures; Risk management process and tools, and key issues, strategies, and international best practices in dealing with geological risks.
3.30pm	<b>Afternoon Teabreak</b>
4.00pm	<b>Rock Engineering Practice for Cavern Construction in Singapore</b> State-of-the-practice in rock engineering for the development of rock caverns in Singapore; systematic rock engineering process incorporating technologies and strategies, practical engineering and simple innovations to ensure consistent quality and achieve cost-effective cavern construction.
5.30pm	<b>Q&amp;A session</b>
6.00pm	<b>End of Theme 2 - Planning and Development of Rock Cavern Facilities</b>

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## ABOUT THE INSTRUCTORS



Er Kiefer Chiam

Er. Kiefer Chiam is currently the Senior Consultant of Geological & GeoSpatial Development Department of Building and Construction Authority (BCA). He is specialist Geotechnical PE registered with Singapore PE Board. His interest and experience spans widely from site investigation works, foundation design, deep excavation to tunnelling and instrumentation works. At BCA, he leads his team in the review of stratigraphy and structural geology in Singapore, and work with the consultant, British Geological Survey to develop a new stratigraphy framework for Geology of Singapore and a 3D geological bedrock model for Singapore and publication of the new geological memoir (2021).



Michael Goay

Michael Goay Kee Hoong is a registered professional geologist in Malaysia specializing in engineering geology. He currently works at the Geological & Geospatial Development Department of the Building and Construction Authority (BCA). His primary role involves providing technical support for tasks related to geological survey. He is also part of the team responsible for developing the 'New Geological Framework of Singapore' and creating the 2021 edition of the Singapore geological map.



Dr Lee Young Zoo

Dr. LEE Young Zoo has more than 26 years of tunnel and geotechnical engineering works in various countries like Singapore, Taiwan, Hong Kong, UAE and Korea as a contractor, consultant and researcher. He finished his bachelor and master in Seoul National University, Korea and PhD in Technical University of Graz, Austria. He is currently a principal engineer in Geoconsult Asia Singapore Pte. Ltd. and working for TBM tunnel project in Singapore and cavern project in UAE. He is also a committee member of Society for Rock Mechanics and Engineering Geology (Singapore) and member of Tunnels and Underground Construction Society (Singapore).



Dr Zhou Yingxin

Dr Zhou Ying Xin is Technical Director with the Knights Synergy (S) Pte Ltd. He was Head Engineering (Underground Facilities) with the Defence Science and Technology Agency (2013 to 2021) and concurrently Assoc (Adj) Prof with the Nanyang Technological University (2011 to 2018) in Singapore. He served as ISRM Vice President for Asia (2011-2015) and first President of the ISRM Commission on Rock Dynamics (2008-2011). Dr Zhou has more than 30 years of experience in research, engineering and teaching in rock engineering and underground space development. He played leading roles in several major rock engineering and research projects and served as technical advisor to several government ministries in Singapore. He led the rock engineering and technology development for the pioneering underground ammunition facility in Singapore and developing new safety standards for underground ammunition storage which have been adopted by NATO. Dr Zhou received the Defence Technology Prize 2018 Individual (Engineering) Award and was featured twice in the Institute of Engineers Singapore (IES) Who's Who in Engineering Singapore in 2013 & 2020. He was a key member of the winning teams for the IES Prestigious Engineering Achievement Awards 2004 and the IES Top 50 Engineering Feats 2016. Dr Zhou is a Fellow of the ISRM and Fellow of the Academy of Engineering Singapore. He is currently a Director (Asia) and Board Member of the Associated research Centers for the Urban underground Space, and member of the Editorial Board for the International Journal of Tunnelling & Underground Space Technology. He has authored/co-authored more than 100 technical papers, nine books and conference proceedings as editor or co-editor, and delivered many keynotes and invited lectures covering topics in rock mechanics, rock dynamics, and underground space.

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