

Thermal Environment

TEACHING GUIDES

M502 – THERMAL ENVIRONMENT - SUGGESTED TIMETABLE

Day 1

0830 – 0900	Introductions
0900 – 0930	Course Overview
0930 – 1030	Thermal Spectrum
1030 – 1100	Coffee Break
1100 – 1230	Principles
1230 – 1330	Lunch Break
1330 – 1500	Effects of Temperature Extremes
1500 – 1530	Coffee Break
1530 – 1700	Thermal Surveys

Day 2

0830 – 0900	Review of Overnight Questions
0900 – 1030	Thermal Comfort
1030 – 1100	Coffee Break
1100 – 1230	Evaluation of Hot Environments
1230 – 1330	Lunch Break
1330 – 1500	Control of Hot Environments
1500 – 1530	Coffee Break
1530 – 1700	Practical on Measurement

Day 3

0830 – 0900	Review of Overnight Questions
0900 – 1030	Case Studies (Hot Environments)
1030 – 1100	Coffee Break
1100 – 1230	Evaluation & Control of Cold Environments
1230 – 1330	Lunch Break
1330 – 1500	Approaches to Risk Assessment
1500 – 1530	Coffee Break
1530 – 1700	Case Studies (Cold Environments)

Day 4

0830 – 0900	Review of Overnight Questions
0900 – 1030	Case Studies (Risk Assessment)
1030 – 1100	Coffee Break
1100 – 1230	Student Exercises
1230 – 1330	Lunch Break
1330 – 1500	Student Exercises
1500 – 1530	Coffee Break
1530 – 1700	Student Exercises

Day 5

0830 – 0900	Review of Overnight Questions
0900 – 1000	Revision
1000 – 1030	Coffee Break
1030 – 1245	Mock Examination
1245 – 1330	Lunch Break
1330 – 1430	Examination Review
1430	Close of Course

The above timetable is provided as a suggestion only and can be altered to meet the customs and requirements of the students and lecturers.

The sequencing of the lectures is such that it broadly follows the sequence of chapters in the Student Manual.

TEACHING GUIDE – DAY 1

THERMAL SPECTRUM

- STUDENT LEARNING OUTCOMES:

1. To understand the range of thermal environments that humans work within.

PRINCIPLES

- STUDENT LEARNING OUTCOMES:

2. Understand the basic physiological responses of the body to hot and cold environments.
3. Understand the process for heat production and exchange.

EFFECTS OF TEMPERATURE EXTREMES

- STUDENT LEARNING OUTCOMES:

4. Understand the effects of hot and cold environments.

THERMAL SURVEYS

- STUDENT LEARNING OUTCOMES:

5. Understand the principles of measuring major environmental factors.
6. Review different monitoring strategies.
7. Understand some approaches to establishing the degree of risk resulting from a thermal survey.

Time (mins)	Topic	Contents	Learning Processes	Learning Resources	Assessment & Learning Outcomes
0 - 30	Course Opening	Welcome	Welcome participants to course	Overhead 1	Familiarisation with Emergency Procedures
30 - 60	Course Overview	Emergency Procedures	Indicate the Site Emergency Procedures to participants	Overhead 2	
		Introductions	Introduce the lecturers and ask participants to introduce themselves	Overheads 3 & 4 (plus extra overheads if more than one lecturer)	
		Course Aims	Indicate the course aims	Overhead 5	
		Overall Learning Outcomes	Indicate what participants can expect to learn	Overheads 6 & 7	
		Topics to be Discussed	Discuss the topics to be covered in the course	Overhead 8	
		Today's Learning Outcomes	Indicate the learning outcomes for Day 1	Overheads 9 & 10	
60 - 120	Thermal Spectrum	Work Groups	Indicate work groups and highlight importance of working as a team	Overhead 11	Active involvement
		Overview	Indicate the role of the sun in all life forms	Overheads 12 & 13	

Time (mins)	Topic	Contents	Learning Processes	Learning Resources	Assessment & Learning Outcomes
120 - 150	Thermal Spectrum (Cont'd)		Discuss the need for humans to control T_c within a narrow range	Overhead 14	Learning Outcome 1
			Discuss variability within humans	Overhead 15	
	Work in Extreme Temperatures	Examples	Highlight areas of extreme temperature (both hot & cold) where humans commonly work	Overheads 16 & 17	
	Work in Moderate Climates	Overview	Discuss why thermal stress incidents occur in moderate temperatures	Overheads 18 & 19	
		Examples		Overhead 20	
	Case Study 1	Heat Stress in a Bakery	This is a group exercise to start activity within the work groups. Ensure a robust group discussion occurs at the end of the exercise to stimulate participation	Overheads 21 & 22	
	Coffee Break				

Time (mins)	Topic	Contents	Learning Processes	Learning Resources	Assessment & Learning Outcomes
150 - 240	Principles	Heat Stress & Heat Strain	Discuss the principles of each and indicate how they are linked	Overheads 23 - 26	Learning Outcome 2
		Homeostasis	Discuss the process of body thermoregulation in detail Highlight the variation in T_{cl} in humans	Overheads 27 - 33	
			Discuss skin temperature and the reasons for variation across the body	Overheads 34 & 35	
		Human Thermoregulation	Highlight the processes of human thermoregulation	Overheads 36 & 37	
		Physiological Responses to Hot Environments	Discuss the various physiological processes that can occur within the human body in hot environments	Overheads 38 - 46	
		Physiological Responses to Cold Environments	Discuss the various physiological processes that can occur within the human body in cold environments	Overheads 47 – 55	

Time (mins)	Topic	Contents	Learning Processes	Learning Resources	Assessment & Learning Outcomes
	Principles (Cont'd)	Psychological Responses	Indicate how thermal stress can influence personal behaviour	Overhead 56	Learning Outcome 3
		Basic Thermodynamics	Discuss the processes of heat production and exchange within the body	Overheads 57 – 60	
		Heat Balance	Highlight the heat balance equation and its importance in understanding heat loss from the body	Overheads 61 – 64	
		Metabolic Heat Production	Describe and illustrate the process of metabolic heat production	Overheads 65 – 68	
		Non Evaporative Transfer	Discuss and illustrate the processes for non evaporative heat transfer	Overheads 69 – 79	
		Evaporative Heat Loss	Discuss the process of heat loss via evaporation	Overheads 80 & 81	
		Acclimatisation	Highlight the importance of acclimatisation, the process and limitations	Overheads 82 – 84	

Time (mins)	Topic	Contents	Learning Processes	Learning Resources	Assessment & Learning Outcomes
240 - 300	Lunch Break				
300 - 390	Effects of Temperature Extremes	Effects of Excessive Heat Strain in Hot Environments	Indicate the various conditions that can occur	Overheads 85 – 101	Learning Outcome 4
		Effects of Excessive Thermal Strain In Cold Environments	Indicate the various conditions that can occur	Overheads 102 - 110	
		Predisposing Factors	Highlight the various factors which can have an influence on thermal stress in humans	Overheads 111 – 121	
390 - 420	Coffee Break				
420 - 510	Thermal Surveys	Measurement Equipment	Indicate how the various parameters (eg temperature, humidity, air movement, etc) are monitored	Overheads 122 – 156	Learning Outcome 5
		Surveys	Discuss the type of data required for basic and complex thermal surveys	Overheads 157 – 160	Learning Outcome 6
			Discuss the various approaches to monitoring strategies	Overheads 161 – 165	

Time (mins)	Topic	Contents	Learning Processes	Learning Resources	Assessment & Learning Outcomes
		Assessment of Risk	Indicate the various approaches to assessing the risk of thermal stress.	Overheads 166 – 173	Learning Outcome 7
	Learning Outcomes	Review of today's Learning Outcomes	Discuss some of the possible control strategies Revise the topics discussed and answer any student questions		
	Overnight Questions		Indicate that answers to the questions can be found in the Student Manual, pages 1-77 Highlight that any queries will be discussed in the first session of Day 2	Overnight questions handout	Active participation

TEACHING GUIDE – DAY 2

REVIEW OF OVERNIGHT QUESTIONS

Receive guidance in understanding the reasons for any incorrect answers to the overnight questions from Day 1.

THERMAL COMFORT

- STUDENT LEARNING OUTCOMES:

1. Understand the concepts of thermal comfort and the relationship between environmental and personal factors.

EVALUATION OF HOT ENVIRONMENTS

- STUDENT LEARNING OUTCOMES:

2. Review the common approaches for evaluating hot environments.
3. Understand the limitations of the various indices.

CONTROL OF HOT ENVIRONMENTS

- STUDENT LEARNING OUTCOMES:

4. Review the various factors that can be used to control hot environments.

PRACTICAL SESSION

- STUDENT LEARNING OUTCOMES:

5. Understand how to use basic thermal environment monitoring equipment.

Time (mins)	Topic	Contents	Learning Processes	Learning Resources	Assessment & Learning Outcomes
0 - 30	Review of Overnight Questions		Hand out the suggested answer sheets Allow time for students to find and check their answers Discuss any concerns	Answer handout	
30 - 120	Thermal Comfort	Today's Learning Outcomes	Discuss the learning outcomes for today	Overheads 2 & 3	
		Principles	Introduce the concept of thermal comfort Indicate the parameters involved and why it can be important	Overheads 4 – 7	
		Subjective Scales	Introduce the two main scales used to evaluate thermal comfort	Overheads 8 & 9	
		Indoor Environments	Indicate the emphasis in both hot and cold environments	Overhead 10	
		Fanger	Discuss the work of P.O. Fanger (1934 – 2006)	Overheads 11 – 18	

Time (mins)	Topic	Contents	Learning Processes	Learning Resources	Assessment & Learning Outcomes
	Thermal Comfort (Cont'd)		<p>Comfort equation based on data collected from 1,296 individuals in early 1970's</p> <p>Discuss PMV and PPD</p> <p>Highlight from graph it is not possible to satisfy everyone even in a neutral environment</p>		
		Local Thermal Discomfort	Indicate causes and discuss each	Overheads 19 – 23	
		Controls for Thermal Comfort	Indicate the various factors which are likely to influence thermal conditions in a building or space	Overheads 24 – 32	Learning Outcome 1
		Case Study 2	<p>Use case study to demonstrate that many industrial disputes can be issues of thermal comfort</p> <p>Highlight very low humidity in pilots' cockpit while in cruise (majority of work period) and then sudden change to high humidity</p> <p>(See explanatory notes on overheads)</p>	Overheads 33 – 51	

Time (mins)	Topic	Contents	Learning Processes	Learning Resources	Assessment & Learning Outcomes
120 – 150	Coffee Break				
150 - 240	Evaluation of Hot Environments	Heat Stress Indices	Define heat stress index and discuss the concept of having a single number to represent a complex thermal environment Remind students of the relationship between heat stress and heat strain	Overheads 52 & 53 Overhead 54	
		Common Indices	Discuss the common indices Indicate their origins, uses and limitations Discuss if they are empirical or rational in derivation	Overheads 55 – 86	
		Physiological Measurements	Discuss the role of direct physiological measurements and what parameters are usually measured	Overheads 87 – 101	Learning Outcomes 2 & 3
240 - 300	Lunch Break				

Time (mins)	Topic	Contents	Learning Processes	Learning Resources	Assessment & Learning Outcomes
300 - 390	Control of Hot Environments	Personal Factors	Indicate and discuss the personal factors which may mitigate against "hot" work	Overheads 102 – 109	
		Acclimatisation	Discuss the process of acclimatisation and its importance	Overheads 110 - 113	
		Engineering Controls	Discuss the various engineering approaches to controlling hot environments	Overheads 114 – 118	
		Administrative Controls	Indicate and discuss the possible administration controls that could be used	Overheads 119 – 125	
		PPE	Discuss the appropriate use of PPE	Overheads 126 – 128	
		AIHA Checklist	Run through the AIHA checklist for controlling hot environments	Overheads 129 - 133	
		Hot Surfaces	Discuss the issue of human skin coming into contact with hot surfaces	Overheads 134 – 144	

Time (mins)	Topic	Contents	Learning Processes	Learning Resources	Assessment & Learning Outcomes
	Control of Hot Environments (Cont'd)		Highlight the factors that influence the severity of burns Discuss burn thresholds Indicate protective measures that may be adopted		Learning Outcome 4
390 - 420	Coffee Break				
420 - 510	Practical Session		Break up into groups Discuss exercises and indicate all must be completed in the allocated time	See practical equipment list Overheads 145 & 146	Learning Outcome 5
		Review of Today's Learning Outcomes	Revise the topics discussed and answer any student questions	Overheads 147 & 148	
	Overnight Questions		Indicate that answers to the questions can be found in the Student Manual, pages 78-144 Highlight that any queries will be discussed in the first session of Day 3	Overnight questions handout	Active participation

TEACHING GUIDE – DAY 3

REVIEW OF OVERNIGHT QUESTIONS

Receive guidance in understanding the reasons for any incorrect answers to the overnight questions from Day 2.

CASE STUDIES (HOT ENVIRONMENTS)

- STUDENT LEARNING OUTCOMES:

1. Highlight various aspects of hot environments using case studies.

EVALUATION AND CONTROL OF COLD ENVIRONMENTS

- STUDENT LEARNING OUTCOMES:

2. Understand the principles of evaluating cold environments.
3. Review approaches to controlling worker exposure in cold environments.

APPROACHES TO RISK ASSESSMENT

- STUDENT LEARNING OUTCOMES:

4. Review various approaches to risk assessment of thermal environments.

CASE STUDIES (COLD ENVIRONMENTS)

- STUDENT LEARNING OUTCOMES:

5. Highlight various aspects of cold environments using case studies.

Time (mins)	Topic	Contents	Learning Processes	Learning Resources	Assessment & Learning Outcomes
0 - 30	Review of Overnight Questions	Today's Learning Outcomes	Hand out the suggested answer sheet Allow time for students to find and check their answers Discuss any concerns	Answer handout	Learning Outcome 1
30 - 120	Case Studies – Hot Environments		Discuss the learning outcomes for today Four (4) case studies are provided to highlight some of the issues discussed The aim is to present each case study and then seek comment and discussion from students (See notes on overheads)	Overheads 2 & 3 Overheads 4 – 55	
120 - 150	Coffee Break				
150 – 240	Evaluation & Control of Cold Environments	Evaluation	Discuss the common indices used to evaluate cold environments	Overheads 56 – 61	Learning Outcome 2

Time (mins)	Topic	Contents	Learning Processes	Learning Resources	Assessment & Learning Outcomes
	Evaluation & Control of Cold Environments (Cont'd)	IREQ	Highlight effect on exposed flesh Discuss the concept of IREQ	Overheads 62 – 66	Learning Outcome 3
		Exposure Standards	Discuss the ACGIH approach of work-warm up schedules and equivalent chilling temperature	Overheads 67 – 71	
		Control of Cold Environments	Indicate the range of various controls and discuss each Topics which should be covered are personal factors, engineering controls, management controls, clothing, selection and use of PPE Highlight the importance of correct clothing	Overheads 72 – 95	
		Working in Cold Conditions	Highlight some of the issues of working in cold conditions (See notes on overheads)	Overheads 96 – 99	

Time (mins)	Topic	Contents	Learning Processes	Learning Resources	Assessment & Learning Outcomes
240 - 300 300 – 390	Evaluation & Control of Cold Environments (Cont'd)	AIHA Checklist	Run through the AIHA checklist for working in cold areas	Overheads 100 & 101	
	Lunch Break				
	Approaches to Risk Assessment	AIOH Approach	Introduce and discuss the AIOH tiered approach	Overheads 102 – 112	
		South African DME Code of Practice	Introduce the South African Department of Minerals & Energy Statutory Code of Practice Highlight the importance of compliance to such Codes	Overheads 113 – 116	
		ACGIH	Introduce and discuss the ACGIH approach	Overheads 117 – 131	
		Quantitative & Qualitative Approaches	Highlight the differences between each approach	Overheads 132 & 133	
		Physiological Assessments	Discuss the role of physiological assessments Highlight the individual employee risk profile used in South Africa	Overheads 134 - 138	

Time (mins)	Topic	Contents	Learning Processes	Learning Resources	Assessment & Learning Outcomes
390 – 420	Approaches to Risk Assessment (Cont'd)		Discuss the need for a standard approach		
	Coffee Break				
420 – 510	Case Studies (Cold Environments)		Use the three (3) case studies to highlight the issues of working in cold environments Encourage discussion by the group	Overheads 139 – 165	
		Review of Today's Learning Outcomes	Review topics discussed and answer any students questions	Overheads 166 & 167	
	Overnight Questions		Indicate that answers to the questions can be found in the Student Manual, pages 154-188 Highlight that any queries will be discussed in the first session of Day 4	Overnight questions handout	Active participation

TEACHING GUIDE – DAY 4

REVIEW OF OVERNIGHT QUESTIONS

Receive guidance in understanding the reasons for any incorrect answers to the overnight questions from Day 3.

CASE STUDIES

- STUDENT LEARNING OUTCOMES:

1. Discuss various case studies to highlight various risk assessment approaches.
2. Discuss other thermal stress issues via the use of case studies.

STUDENT EXERCISES

- STUDENT LEARNING OUTCOMES:

3. Undertake a number of calculation exercises and workplace case scenarios to reinforce the learnings contained in the lectures.

Time (mins)	Topic	Contents	Learning Processes	Learning Resources	Assessment & Learning Outcomes
0 - 30	Review of Overnight Questions		Hand out the suggested answer sheet Allow time for students to find and check their answers Discuss any concerns	Answer handout	
30 – 120	Case Studies Risk Assessment	Today's Learning Outcomes	Discuss today's learning outcomes	Overhead 2	Learning Outcome 1
		Case Study 10	The case study involves three scenarios, details of which can be found in the notes pages of the overheads The aim is to demonstrate the use of the AIOH risk assessment approach All three steps are highlighted, including physiological monitoring Discuss this approach with students and seek their views	Overheads 3 - 28	
		Case Studies 11 & 12	Both case studies are from the South African Mining Industry.	Overhead 29	

Time (mins)	Topic	Contents	Learning Processes	Learning Resources	Assessment & Learning Outcomes
	Case Studies Risk Assessment (Cont'd)		Both indicate severe system failures with fatal outcomes Use these case studies to discuss what caused the fatalities and what could have been done to prevent them happening		
		Case Study 13	This is a simple case to highlight the importance of adequate acclimatisation	Overheads 45 - 48	
		Case Study 14	A simple case study to demonstrate that exertion in cold climate clothing leads to excessive heat generation and removal can lead to cold stress conditions upon cooldown	Overheads 49 - 51	
120 – 150	Coffee Break				
150 – 240	Student Exercises	Calculation Exercises	Students should break into groups and attempt calculation exercises	Overheads 52 & 53	

Time (mins)	Topic	Contents	Learning Processes	Learning Resources	Assessment & Learning Outcomes
240 – 300	Student Exercises (Cont'd)		Lecturer should assist where required and ensure all groups obtain the correct answers	Questions and answers handouts	Learning Outcome 2
	Lunch				
		Student Assessment Exercises (including Coffee Break)	Each group will be provided with three situations to evaluate and answer the required questions As the coke ovens scenario is unusual (but true) a description of the process should be provided to students Notes on this aspect are provided in the presentation slides In the event a group finishes very early, a fourth scenario (Thermal Comfort) should be distributed to allow the other groups to catch up	Overhead 54 Questions and answers handouts Overheads 55 - 61	
		Review of Today's Learning Outcomes	Review topics discussed and answer any students questions	Overheads 62 & 63	Learning Outcome 3

Time (mins)	Topic	Contents	Learning Processes	Learning Resources	Assessment & Learning Outcomes
	Overnight Questions		Indicate that answers to the questions require at least a half page answer and can come from anywhere in the Student Manual Highlight that any queries will be discussed in the first session of Day 5	Overnight questions handout	Active participation

TEACHING GUIDE – DAY 5

REVIEW OF OVERNIGHT QUESTIONS

Receive guidance in understanding the reasons for any incorrect answers to the overnight questions from Day 4.

REVISION

- STUDENT LEARNING OUTCOMES:

1. Revise those sections of course that present difficulty.

MOCK EXAMINATION

2. Attempt a mock examination to highlight possible areas of further study.

Time (mins)	Topic	Contents	Learning Processes	Learning Resources	Assessment & Learning Outcomes
0 - 30	Review of Overnight Questions		Hand out the suggested answer sheet Allow time for students to find and check their answers Discuss any concerns	Answer handout	
30 – 90	Revision		Seek questions from students as to any areas of concern. If no questions arise suggest students use the time to study for the mock examination		Learning Outcome 1
90 – 120	Coffee Break				
120 – 195	Mock Examination		Run mock examination under “real” conditions, ie independent supervisor, no talking, etc Provide answers to students after they leave the examination room	Answer sheet handout	Learning Outcome 2
195 – 240	Lunch				

Time (mins)	Topic	Contents	Learning Processes	Learning Resources	Assessment & Learning Outcomes
240 – 300	Examination Review		Revise any questions that the students request		