Useful information for attending our Sonar courses

Location

Both courses will be held in the Inspire Lecture Theatre in our Fusion Building, which is located on our Talbot Campus. A map to the campus is available on page 3 and a campus map can be found on page 4.

Car Parking

We are unfortunately no longer able to offer free parking for our visitors or event attendees. Paid parking is available at our Visitor & Events Car Park, indicated on the campus map on page 4. This parking can be paid for at the ticket machine in the car park, or in advance via https://pay.hozah.com/locations/1167

Bus Service

Buses for BU are operated by More, the bus service that serves the University, during the vacation this is restricted to a shuttle service (Route U1) between the location of one of the largest halls of residence and Talbot Campus (where the Sonar Course takes place) as well as other services www.morebus.co.uk Yellow buses also operate services that call at the University full details of routes and timetables can be found at www.bybus.co.uk

Lunch and Refreshments

Lunch is included in the course fee and will be via vouchers provided to you on your arrival. These vouchers can be redeemed in The Fusion Building restaurant. Tea, coffee, water, Danish pastries or biscuits and fruit will be provided in the morning, with tea/coffee/water and biscuits available in the afternoon.

Course Notes

A set of course notes will be provided as per the option that was chosen when you were registered on the course (physical copy, digital copy on a USB flash drive, or digital copy by email).

Certificate of Completion

Following the course, you will be provided with a certificate confirming your completion of the course.

COVID-19

If you have symptoms prior to attending these courses please take a Lateral Flow test to ensure you don't expose other attendees to COVID. If you develop symptoms during the course you must let us know as soon as possible and are required to follow NHS guidance to self-isolate.

We look forward to welcoming you to Bournemouth University and wish you a pleasant journey.

Faculty of Science and Technology
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sonar@bournemouth.ac.uk

Accommodation

If accommodation is required, this can be booked by contacting any of the below suggestions. It should also be noted that Bournemouth and Poole have a large number of hotels if the below do not meet your requirements.

- The **Bournemouth Highcliff** Marriot Hotel is on the clifftops at Bournemouth. Find out more at their website www.BournemouthHighcliffMarriott.co.uk.
- The **Oceana Group** of Hotels which include **The Cumberland, Ocean Beach, Royale, Suncliffe** and **Mayfair** are all about 15 minutes' drive from the University, and not far from the seafront. They can be contacted on 01202 298350 or email Central Reservations at cr@oceanahotels.co.uk. More information is on their website www.oceanahotels.co.uk.
- The **Cottonwood Boutique Hotel** is also 15 minutes' drive from the University and can be contacted on 01202 553183. For more information and to book, see the website http://www.quantumhotelgroup.co.uk/
- The **Encore Hotel** (Ramada Hotels) is also 15 minutes' drive from the University and can be contacted on 01202 291266. For more information, see the website http://www.encorebournemouth.co.uk/.
- The **Miramar Hotel** is similarly located and can be contacted on 01202 410156, and on their website www.miramar-bournemouth.com.
- The **Green House Hotel** is also in this area and can be contacted on 01202 498900 or via the website www.thegreenhousehotel.co.uk
- Finally, **the Village Hotel** is located on the outskirts of Bournemouth just off the A338. It can be contacted on 01202 055205 and more information is on the website www.village-hotels.co.uk

Alternatively, you can access online accommodation lists and bookings by visiting the below websites:

- www.bournemouth.co.uk and follow the links to Accommodation
- http://www.pooletourism.com/ and follow the links to Book Accommodation online

Please note that delegates are responsible for arranging and paying for their own travel and overnight accommodation. There are a large number of taxis operating in the town, and these can be booked by your hotel. In addition, there is also a shuttle bus that operates between the Lansdowne (where a number of hotels are) and Talbot Campus where the course is being held.

Bournemouth University

How to find us

To reach **Lansdowne Campus** from the north or east, leave the A338 at the junction marked Travel Interchange onto St Paul's Road, then take St Swithuns Road. At the roundabout at the end of St Swithuns Road, take the right-hand exit which will bring you onto Christchurch Road (B3066) where the buildings that comprise the campus are located.

From the west, follow the directions to Talbot Campus but proceed past the university on the A3049 (this becomes Talbot Avenue). Next take Wimborne Road (A347), then Lansdowne Road (B3064) to continue onto Christchurch Road (B3066).

Postcode for Sat Nav: BH8 8EB

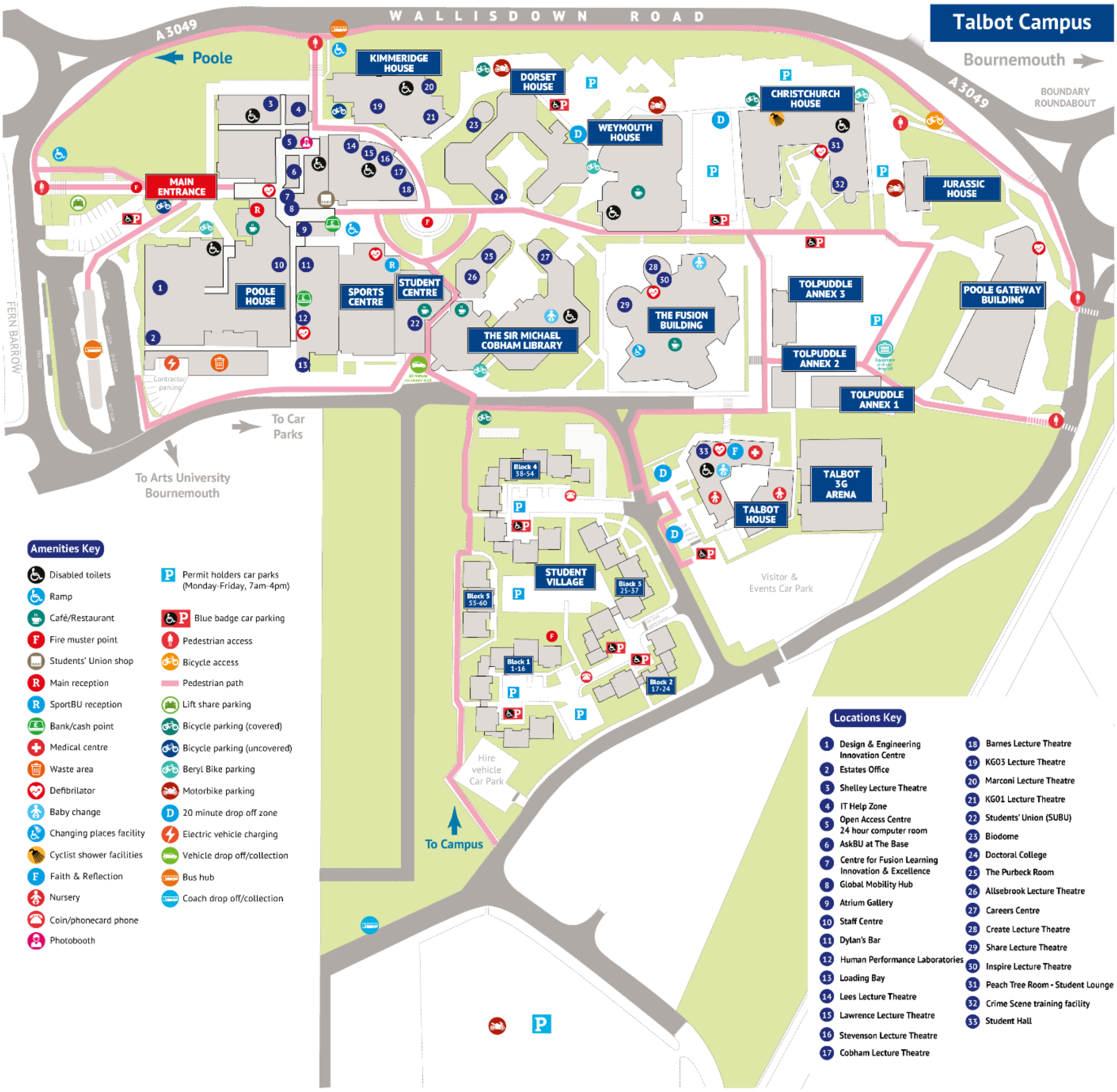
Talbot Campus can be reached from the north or east via the A338 (locally known as the Wessex Way). Take the exit at the Richmond Hill Roundabout (next to the Vitality Insurance tower) and then follow the signs for the university.

From the west on the A35 follow the signs to Bournemouth (A3049), taking the dual-carriageway (Dorset Way) past Tower Park. Talbot Campus is located on the A3049 (Wallisdown Road).

Talbot Campus has a limited number of pay and display visitor parking bays. Student and staff parking is for permit holders only.

Postcode for Sat Nav: BH12 5BB

Talbot Campus Map



An interactive version of this map is available on our website on [this link]

INTRODUCTION to SONAR

to be held at

BOURNEMOUTH UNIVERSITY

8th September – 12th September 2025

PROVISIONAL TIMETABLE

Monday	Introduction to Sonar Day 1– (Fusion Building, Inspire LT)	Tutor	Notes section
09:00 - 09:15	***Arrival – Fusion Building (Inspire LT)***	Prof Philip Sewell	
09:15 – 09:30	Welcome & Introduction	BU Dr Graham Alker	
09:30 – 10:00	Basics of Sonar	Dr Graham Alker	I1
	Coffee		
10:15 – 12:30	Acoustic Wave Motion	Dr Graham Alker	I2
	LUNCH		
13:30 – 14:30	Acoustic Propagation & Sonar Equation	Dr Graham Alker	I3
	Coffee		
14:45 – 15:15	dB Exercises	Dr Graham Alker	
15:15 – 16:30	Sonar - Transducers & Beamforming	Dr Graham Alker	I4
Tuesday	**Day 2**		
09:00 – 10:30	Noise & Reverberation	Dr Jim Parberry	I5
	Coffee		
10:45 – 12:00	Signal Processing & Displays	Dr Jim Parberry	I6
12:00 – 12:30	Arrays	Dr Jim Parberry	I7
	LUNCH		
13:00 – 15:15	Experimental Demonstrations (PG141)/Software Demonstration (Inspire LT)	Dr Diogo Montalvao/ Dr Jim Parberry	I8
	Coffee		
15:30 – 16:30	Sonar Systems Reviewed and Tutorial Questions	Dr Jim Parberry	I9

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FUNDAMENTALS OF SONAR
to be held at
BOURNEMOUTH UNIVERSITY
8th September – 12th September 2025

PROVISIONAL TIMETABLE

Wednesday	Fundamentals of Sonar Day 1 – (Fusion Building, Inspire LT)	Tutor	Notes section
09:00 - 09:15	*Arrival – Fusion Building (Inspire LT)*	Prof Philip Sewell	
09.15 – 10.15	Acoustic Wave Theory	Dr Graham Alker	F1
	Coffee		
10:30 – 11:30	Acoustic Wave Theory - continued	Dr G Graham Alker	F1
11:30 – 12.30	Fourier Methods	Dr G Graham Alker	F2
	LUNCH		
13:30 – 14:45	Transducer Technology	Thales	F3
	Coffee		
15.00 – 15:30	Transducer Technology - continued	Thales	F3
15:30 – 17:15	Sonar Imaging Systems	Dr Alfie Anthony Treloar	F4
Thursday	**Day 2**		
09.00 – 10:00	Radiated Noise	QinetiQ	F5
	Coffee		
10.15 – 12:00	Target Echo Strength	David Nunn	F6
12:00 – 13:00	Signal Processing and Displays	Kaon Ltd	F7
	LUNCH		
13.30 – 15.00	Data Processing	Kaon Ltd	F8
15:00 – 15:15	***Coffee***		
15:15 – 17:00	Towed Arrays	Atlas Elektronik UK	F9
Friday	**Day 3**		
09.00 – 10.30	Propagation	Marcus Donnelly	F10
	Coffee		
10.45 – 11:45	The Sonar Equation	Marcus Donnelly	F11
11:45– 13:15	Sonar Equation Calculations & Tutorial	Marcus Donnelly	F11
	LUNCH		

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Optional Algebra Revision

Dr Graham Alker, who delivers some of the lectures on the sonar course has asked that we include this for all delegates so that they can brush up on some of the relevant principles of algebra as they relate to sonar if they choose to. The feedback that we have received from previous courses indicates that many find this useful.

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Algebra revision for Introduction to Sonar

This is intended to give a simple reminder and the opportunity to practise some useful techniques for those whose mathematics is rusty. It is not a rigorous mathematical introduction. The correct answers to all **practice** questions are within [ ] and long decimal answers are truncated. It is recommended *but not necessary* that the practice questions are attempted.
Decibels (dB) are used extensively in acoustics and use the function $\log_{10}(x)$.
Practice examples are given using $\log_{10}(x)$ and $\mathbf{10^x}$.

Functions

A function is a rule which maps a set of numbers to another set of numbers. It is simple: give the function a number and it responds with a number.
Example $f(x) = 2x^2 + 3$ note x is called the 'argument',
Giving the function the number 2, or equivalently setting $x = 2$, $f(x) = 11$

The usual method of evaluation for $f = 2x^2 + 3$ when x=7 is:

$$f = 2 \times x^2 + 3$$
$$f = 2 \times 7^2 + 3$$
$$f = 2 \times 49 + 3$$
$$f = 98 + 3$$
$$f = 101$$

Practice:

Evaluate f(x) = 10x-7	for x = 2	[13]
	for x = 3.7	[30]
	for x = -1	[-17]
Evaluate f(x) = $3x^2$ +4	for x = 2	[16]
	for x = 3.7	[45.07]
	for x = -1	[7]

Inverse functions

Given a function $f(x)$ and a value of the function, what was the value of x which led to this? This is the inverse function often denoted as $f^{-1}(x)$
Example $f = 2x + 3$ *if* $f = 5$, what was x? The answer is $x = 1$

The method of finding x for $f = 2x^2 + 3$ when f=21 is:

$$2x^2 + 3 = 21$$
$$2x^2 = 18$$
$$x^2 = 9$$
$$x = \sqrt{9}$$
$$x = \pm 3$$

Practice:

$f(x) = 10x-7$	find x	when f = 3	[1]
		when f = 8	[1.5]
$f(x) = 3x^2 +4$	find x	when f = 31	[±3]
		when f = 8	[±1.1547…]
		when f = 2	[no real solution]

Powers and logarithms

Raising a number or a variable to a power indicates the number of times it should be multiplied by itself. The notation is x^n which is interpreted as x multiplied by itself 'n' times. 'n' is referred to as the exponent. This was introduced as a shorthand and initially was only defined for positive integers 1,2,3 … The first three powers of the number 10 are thus:

$10^1 = 10 \qquad 10^2 = 10\times 10 = 100 \qquad 10^3 = 10\times 10\times 10 = 1000 \quad ….$

Multiplying turns out to be easy: to multiply 10^2 by 10^3, the safe way is to write them out as ordinary numbers, multiply and rewrite in the exponent notation:

$10^2 \times 10^3 = 10\times 10 \quad \times \quad 10\times 10\times 10 \quad = 10^5$

In general, for two exponents m and n

$10^m \times 10^n = 10^{m+n}$

Dividing is similar: divide 10^3 by 10^2

$10^3 / 10^2 = 10\times 10\times 10 \,/\, (10\times 10) = 10 = 10^1$

In general, for two exponents m and n

$10^m / 10^n = 10^{m-n}$

There are potential problems here, if m=n then the answer would be 10^0, what does this mean? Of course, we know the answer: $10^2 / 10^2 = 1$ so we define $10^0 = 1$ and the definition of powers is extended to 0,1,2,3 …

If m<n, for example: $10^2 / 10^3 = 10^{-1}$ the exponent is negative, what does this mean? We know that 100/1000 is 1/10, so it appears that 10^{-m} simply means $1/10^m$. Check: 100/10000=1/100 by powers:

$10^2 / 10^4 = 10^{-2} = 1/10^2$

So, we define $10^{-m} = 1/10^m$ The definition of powers is now extended to both positive and negative numbers and zero.

Next consider $(10^3)^4 = (10^3)\times(10^3)\times(10^3)\times(10^3) = 10^{12}$

so $(10^n)^m = 10^{nm}$

The rules for manipulating powers are:

$10^m \times 10^n = 10^{m+n}$, $(10^n)^m = 10^{nm}$, $10^m / 10^n = 10^{m-n}$, $10^0 = 1$, $10^{-m} = 1/10^m$

10 has been used as an example. In general, for any numbers x, m, n, $x \neq 0$

$x^m \times x^n = x^{m+n}$, $(x^n)^m = x^{nm}$, $x^m / x^n = x^{m-n}$, $x^0 = 1$, $x^{-m} = 1/x^m$

Fractional powers

Multiplying a number by itself a half a number of times does not sound sensible. However, a sensible value of $10^{0.5}$ can be found. If this number is multiplied by itself applying the rule above:

$10^{0.5} \times 10^{0.5} = 10^1 = 10$

hence $10^{0.5} = \sqrt{10}$

This can be extended, for example $10^{0.7}$ can be interpreted as the tenth root of 10 multiplied by itself 7 times ie $(10^{0.1})^7$ In this way an understanding of 10^x can be defined for all real values of x.

Practice using a calculator:

Evaluate 10^5	[100000]
Evaluate 10^2	[100]
Evaluate 10^{-3}	[0.001]
Evaluate $10^{1.376}$	[23.7684]

log(x) (formally $\log_{10}(x)$) is the inverse function of 10^x

$10^3 = 1000$ $\quad\quad$ $\log(1000) = 3$

$10^{2.5} = 316.2278$ $\quad\quad$ $\log(316.2278) = 2.5$

log(1) = 0
log(xy) = log(x) + log(y)
log(x/y) = log(x) - log(y)
log(1/y) = - log(y)

Practice:

Evaluate 10^4	[10000]
Evaluate $\log_{10}(10000)$	[4]
Evaluate $\log_{10}(38.4)$	[1.58433]
Evaluate $10^{1.58433}$	[38.4]

Question $\quad$ If $\log_{10}(x) = 1.8$ what is x? $\quad$ Answer $\quad$ $x = 10^{1.8} = 63.096$

Practice:

If $\log_{10}(x) = 0.8$ what is x?	[6.3096]
If $\log_{10}(x) = -1.4$ what is x?	[0.0398]
If $\log_{10}(x) = 4.4$ what is x?	[25188.9]

Question $\quad$ If $10\log_{10}(x) = 23$ what is x?

$\log_{10}(x) = 23/10 = 2.3$

$x = 10^{2.3}$

$x = 199.5$

Practice:

If $10\log_{10}(x) = 60$ what is x? [1000000 = 10^6]

If $10\log_{10}(x) = 64$ what is x? [2511886]

If $20\log_{10}(x) = 64$ what is x? [1584.9]

If $20\log_{10}(x) = 49$ what is x? [281.8]

Practice:

Evaluate $\log_{10}(10)$ [1]

Evaluate $\log_{10}(1000)$ [3]

Evaluate $\log_{10}(0.001)$ [-3]

Evaluate $\log_{10}(2)$ [0.3]

Evaluate $\log_{10}(3)$ [0.48]

Evaluate $\log_{10}(6)$ [0.78]

So $\log_{10}(2) + \log_{10}(3) = \log_{10}(6)$

Evaluate $\log_{10}(4)$ [0.6]

Evaluate $\log_{10}(40)$ [1.6]

Evaluate $\log_{10}(0.4)$ [-0.4]

Learn the following:

$\log_{10}(10) = 1$

$\log_{10}(10^n) = n$

$\log_{10}(2) = 0.3$

Algebra revision for Fundamentals of Sonar

Complex Numbers

A complex number z may be written

$$z = x + iy$$

Here the real part is x and imaginary part is y and i is √(-1)

Addition of complex numbers is as expected, if $d = a + ib$ then

$$z + d = x + a + i(y + b)$$

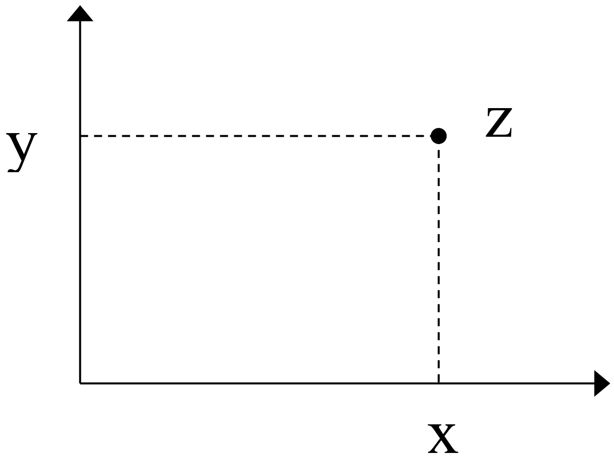
Multiplication uses the relation $i^2 = -1$

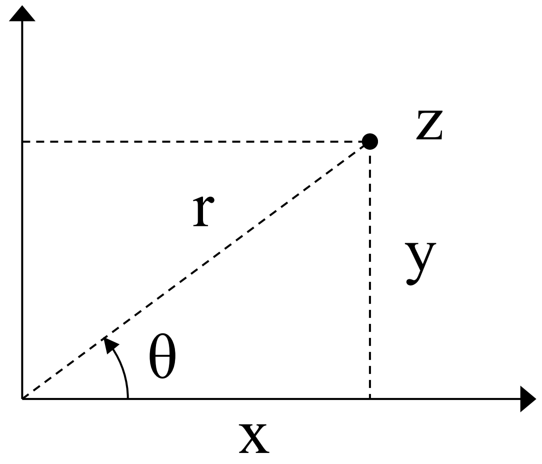
$$zd = (x + iy)(a + ib) = xa - yb + i(xb + ya)$$

Practice:
If $z = 2 + 3i$, $d = 2 + i$, and $w = 2 - 3i$,

Evaluate $z + d$ [4+4i]
Evaluate zd [1+8i]
Evaluate $z + w$ [4]
Evaluate zw [13]

Complex numbers may be represented in a 2-D plane:





Then $x = r\cos\theta, y = r\sin\theta, \quad r = \sqrt{x^2 + y^2}$

Recall $e^{i\theta} = \cos\theta + i\sin\theta, \quad \theta\ radians$

Therefore $z = \mathrm{r}(\cos\theta + i\sin\theta) = re^{i\theta}$

The real part of a complex number z is written as

$\Re(z) = x = r\cos\theta$

It is useful to write a complex number in the form $re^{i\theta}$

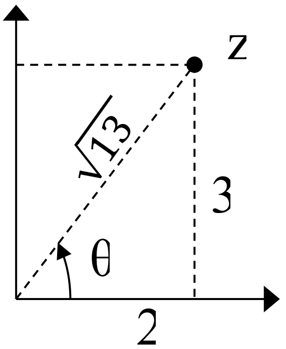
Example
Write z = 2+3i in the form $re^{i\theta}$

$r = \sqrt{13} \qquad \theta = \cos^{-1}(2/\sqrt{13})$

$$z = \sqrt{13}\, e^{i\cos^{-1}(2/\sqrt{13})}$$

z = 3.6056$e^{0.9828i}$

similarly, *w* = 3.6056$e^{-0.9828i}$



Note w is the complex conjugate of z, the real parts are the same, the imaginary parts have opposite signs

Practice

Write z in the form $re^{i\theta}$

z	$re^{i\theta}$
2	[2]
-3	[$3e^{i\pi}$]
4i	[$4e^{i\pi/2}$]
1+i	[$\sqrt{2}\ e^{i\pi/4}$]
-6i	[$6e^{-i\pi/2}$]