KOLEJ UNIVERSITI TEKNOLOGI TUN HUSSEIN ONN

PEPERIKSAAN AKHIR
SEMESTER I
SESI 2006/07

NAMA MATAPELAJARAN	:	GETARAN & KEBISINGAN
KOD MATAPELAJARAN	:	BDC 4013/ BKM 5073
KURSUS	:	4 BDA / 5 BKM
TARIKH PEPERIKSAAN	:	NOVEMBER 2006
JANGKAMASA	:	3 JAM
ARAHAN	:	JAWAB **LIMA (5)** SOALAN DARIPADA ENAM **(6)** SOALAN.

KERTAS SOALAN INI MENGANDUNGI 20 MUKASURAT

S1 (a) Satu respon getaran bebas bagi sistem jisim pegas dikatakan mempunyai frekuensi tabii 10 rad/s. Keadaan awal bagi sistem tersebut ialah x_0=0.05m and $\dot{x}_0 = 1\,m/s$, tentukan

i) anjakan x(t)

ii) halaju, $\dot{x}_0(t)$ dan

iii) pecutan, $\ddot{x}_0(t)$ bagi sistem

Lakarkan sambutan bagi x(t), $\dot{x}_0(t)$, $\ddot{x}_0(t)$ bagi masa t=1 hingga 3 s.

[Pertimbangkan $x(t) = Ce^{-\xi\omega n t}\cos(\omega_d t-\phi)$]

(8 markah)

(b) Satu jisim m dihubungkan dengan seutas tali pada sebuah cakera membulat yang homogen seperti ditunjukkan dalam **Rajah S1**. Jika jisim tersebut dianjakkan ke bawah dari keadaan rehat, tentukan frekuensi tabii bagi sistem dengan kaedah keabadian tenaga.

(12 markah)

S2 Satu kenderaan dimodelkan dengan keupayaan pergerakan secara sudut dan secara lelurus, seperti ditunjukkan dalam **Rajah S2**. Lokasi pusat pergerakan (nod) bagi data kenderaan tersebut diberikan sebagai yang berikut : jisim (m) = 1,000 kg, jejari kisar = 0.9 m, l_1 = 1.0 m ,l_2 = 1.5 m, k_f=18kN/m, k_r=22kN/m, halaju=50 km/hr. Tentukan

(a) frekuensi tabii

(b) nisbah amplitud dan bentuk ragam

Persamaan gerakan dalam bentuk matriks diberikan sebagai,

$$\begin{bmatrix} (-m\omega^2 + k_1 + k_2) & (-k_1L_1 + k_2L_2) \\ (-k_1L_1 + k_2L_2) & ((J_0\omega^2 + k_1{L_1}^2 + k_2{L_2}^2) \end{bmatrix} \begin{Bmatrix} x \\ \theta \end{Bmatrix} = \begin{Bmatrix} 0 \\ 0 \end{Bmatrix}.$$

(20 markah)

S3. (a) Berasaskan prinsip pertama, terbitkan persamaan gelombang lenturan bagi rasuk, diberikan sebagai

$$EI\frac{\partial^4 u}{\partial x^4} + \rho A\frac{\partial^2 u}{\partial t^2} = 0$$

dengan,

E = modulus Young

I = momen inersia rasuk

ρ = ketumpatan rasuk

A = luas keratan rentas rasuk

u = anjakan

(b) Menggunakan persamaan dalam bahagian (a), tunjukkan bahawa bagi satu rasuk mengufuk, terdapat empat gelombang di dalam rasuk ini, iaitu dua gelombang bergerak ke kiri dan dua lagi bergerak ke kanan.

(c) Dapatkan frekuensi tabii dan bentuk getaran pada rasuk yang terletak di atas penyokong seperti dalam **Rajah S3** apabila rasuk tersebut mengalami getaran secara melintang. L ialah panjang rasuk tersokong mudah..

[Ambil anjakan u sebagai:

$u = (A_1 \text{ kosh } kx + A_2 \sinh kx + A_3 \text{ kos } kx + A_4 \sin kx)(B \sin \omega t + C \text{ kos } \omega t)$

dengan, $k = \sqrt[4]{\omega^2 \frac{\rho A}{EI}}$, A_i, B dan C = pemalar]

(20 markah)

S4 (a) Terangkan dengan ringkas maksud kebisingan dalam erti kejuruteraan dan jelaskan kesan terhadap pekerja industri.

(4 markah)

(b) Merujuk kepada **Rajah S4(b)**, terangkan secara ringkas peringkat kehilangan pendengaran.

i) pendengaran normal
ii) kehilangan pendengaran sementara
iii) kehilangan pendengaran kekal

(6 markah)

(c) Anda ialah seorang jurutera di Unit Keselamatan dan Kesihatan Pekerja sebuah syarikat tekstil. Berdasarkan kepada **Rajah S4(c)**, berikan pandapat anda serta cadangan anda bagaimana untuk mengelak atau untuk mengurangkan hilang pendengaran daripada terus meningkat.

(10 markah)

S5 (a) Jelaskan perbezaan antara penyerap bunyi dan penebat bunyi. Lukiskan rajah yang sesuai untuk membuktikan perbezaan tersebut.

(6 markah)

(b) Sebuah kilang tekstil mempunyai ruang kerja yang luas untuk menempatkan mesin-mesin untuk proses menjahit. Ruang kerja tersebut ialah 40 m panjang, 20 m lebar dan 8 m tinggi. Lantai dan dinding ruang kerja tersebut diperbuat daripada konkrit manakala atap dipasangkan dengan kepingan keluli. Sekiranya pemalar bilik R tersebut ialah 284 m^2, dapatkan:

i) purata pekali penyerapan ruang kerja , $\overline{\alpha}$.
ii) keadaan persekitaran akustik ruang kerja dengan merujuk pada **Jadual S5**.
iii) masa penggemaan, RT

(10 markah)

(c) Berdasarkan kepada soalan S2(b), sekiranya kesemua mesin jahit beroperasi dan menghasilkan bunyi 100 dB(A). Tentukan SPL pengemaan dengan melakarkan graf penggemaan.

(4 markah)

S6 (a) Jelaskan **EMPAT (4)** faktor untuk mereka bentuk sebuah penebatan kebisingan dan terangkan dengan ringkas faktor-faktor tersebut.

(4 markah)

(b) En. Ramlee mempunyai pejabat yang berada di dalam sebuah bengkel di mana ia telah dibina dengan menggunakan dinding bati dua lapisan setebal 300 mm. Isipadu ruang bengkel tersebut ialah 3000 mm^3 dan mempunyai masa penggemaan 2 s. SPL pengemaan pada bengkel tersebut ialah 72 dB, tentukan:

i) kehilangan hantaran (TL) dinding pejabat.
ii) pemalar bilik, $\overline{\alpha}$.
iii) SPL penggemaan di dalam pejabat

Anggapkan dimensi pejabat ialah 4m panjang, 3m lebar dan 2.5 tinggi. Manaka pekali penyerapan pejabat ialah 0.1.

(9 markah)

(c) Sebuah bilik yang diperbuat daripada selapisan dinding batu bata setebal 125 mm, selapis tingkap kaca setebal 6 mm dan papan lapis setebal 6 mm dengan masing-masing mempunyai luas ialah 4 m^2, 4 m^2 dan 2 m^2, dapatkan:

i) kehilangan hantaran antara dinding batu bata dengan kaca tingkap.
ii) kehilangan hantaran pada kesemua bahan.

(7 markah)

English Section.

S1 (a) The free vibration response of a spring mass system is observed to have a natural frequency of 10 rad/s. The initial conditions of the system are x_0=0.05m and $\dot{x}_0 = 1\,m/s$, determine

i) the displacement, x(t)

ii) velocity, $\dot{x}_0(t)$ and

iii) acceleration, $\ddot{x}_0(t)$

Sketch the response of x(t), $\dot{x}_0(t)$, $\ddot{x}_0(t)$ from t=0 to 3 seconds

[Apply $x(t)= Ce^{-\xi\omega n t}\cos(\omega_d t-\phi)$]

(8 marks)

(b) The mass m is hanging from a cord attached to the circular homogeneous disc to mass m as shown in **Rajah S1**. If the mass is displaced downward from the rest position, determine the natural frequency of the system using the energy method.

(12 marks)

S2 An automobile is modeled with a capability of pitch (angular motion) and bounce (up and down in linear motion) frequencies, as shown in **Rajah S2**. The location of oscillation centers (nodes) of an automobile data is given as the following :
mass (m) = 1,000 kg, radius of gyration = 0.9 m, l_1 = 1.0 m, l_2 = 1.5 m, k_f=18kN/m, k_r=22kN/m. Determine

(a) the natural frequencies

(b) the amplitude ratios and mode shapes

The equation of motion in matrix form is given by,

$$\begin{bmatrix} (-m\omega^2 + k_1 + k_2) & (-k_1L_1 + k_2L_2) \\ (-k_1L_1 + k_2L_2) & ((J_0\omega^2 + k_1L_1^{\,2} + k_2L_2^{\,2}) \end{bmatrix} \begin{Bmatrix} x \\ \theta \end{Bmatrix} = \begin{Bmatrix} 0 \\ 0 \end{Bmatrix}.$$

(20 marks)

S3. (a) Derive from the first principles, that the flexural wave equation of a uniform beam is given by:

$$EI\frac{\partial^4 u}{\partial x^4} + \rho A\frac{\partial^2 u}{\partial t^2} = 0$$

where,

E = Young's modulus

I = moment inertia of the beam

ρ = mass density of the beam

A = cross sectional area

u = displacement

(b) Using the equation in (a), shows that for a horizontal beam there are four (4) waves, where two waves move to the right and another two waves move to the left.

(c) Find the natural frequencies and mode shapes of vibration for simply supported beam as shown in **Rajah S3,** when the beam is experienced transverse vibration. L is the length of the simply supported beam.

(20 marks)

S4 (a) Explain briefly the meaning of noise in engineering field and state the effects of noise to industrial workers.

(4 marks)

(b) Referring to **Rajah S4(b)**, explain briefly the level of hearing loss.

i) normal hearing
ii) temporary hearing loss
iii) permanent hearing loss

(6 marks)

(c) You are an engineer at Department of Safety and Workers Health Unit at textile company. Based on **Rajah S4(c)**, give your opinions and suggestions how to avoid or to reduce the percentage of permanent hearing loss.

(10 marks)

S5 (a) Explain the differences of sound absorption and sound insulation. Sketch a figure to prove the differences.

(6 marks)

(b) A textile factory work place is used to place all the sew machines. Dimension of working area is 40 m length, 20 m width and 8 m height. The floor and wall surface are made from concrete with sheet metal decking for roof. If the room constant, R is 284 m^2. find:

i) average room absorption coefficient, $\overline{\alpha}$
ii) room acoustic environment by referring to **Jadual S5**
iii) time reverberations, RT

(10 marks)

(c) Referring to Question S2(b), if all the sew machines are operated on the same time and generate 100 dB(A); determine the reverberation SPL by sketching the reverberation graph.

(4 marks)

S6 (a) Describe **FOUR (4)** factors to create a noise insulation and explain briefly the factors.

(4 marks)

(b) En Ramlee's office is in the workshop where the office was constructed with double masonry walls includes 300 mm width. The volume of the workshop is 3000 m^3 with the time reverberation is 2 s. The reverberation SPL at the workshop is 72 dB(A), determine:

i) transmission loss (TL) of office wall.

ii) room constant, $\overline{\alpha}$.

iii) reverberation SPL at the office.

Assume that dimension of the office is 4 m length, 3 m width and 2.5 height. While the average room absorption coefficient is 0.1.

(9 marks)

(c) A room was constructed from single masonry walls with 125 mm width, single glazed window with 6 mm width and plywood with 6 mm width. The area of each material was 4 m^2, 4 m^2 and 2 m^2, respectively, find:

i) transmission loss (TL) between single masonry walls and single glazed window.

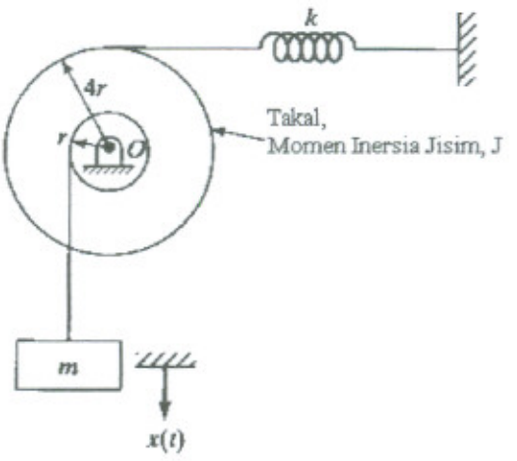
ii) total transmission loss (TL)

(7 marks)

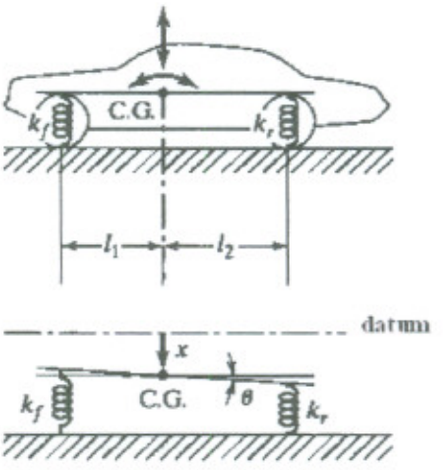
PEPERIKSAAN AKHIR

SEMESTER/SESI : 1/2006/2007 KURSUS : 4 BDA / 5 BKM

MATA PELAJARAN : GETARAN & KEBISINGAN KOD MATA PELAJARAN : BDC 4013/ BKM5073



Rajah S1

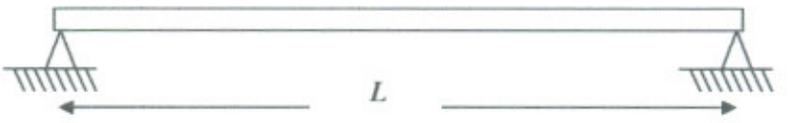


Rajah S2

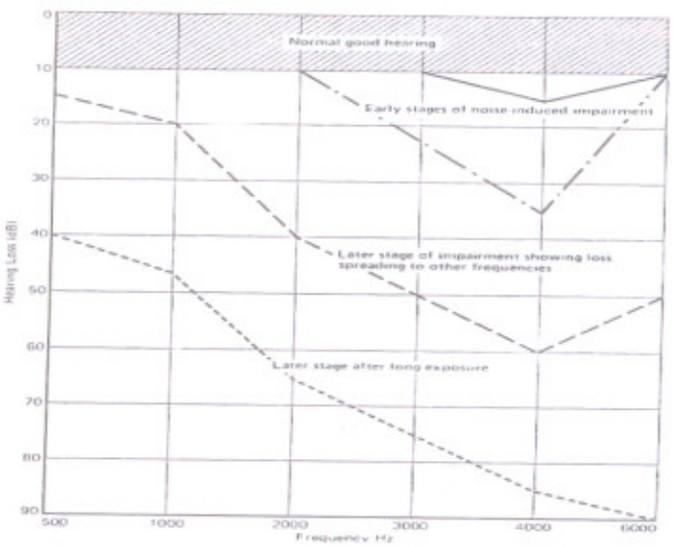
PEPERIKSAAN AKHIR

SEMESTER/SESI : 1/2006/2007 KURSUS : 4 BDA / 5 BKM

MATA PELAJARAN : GETARAN & KEBISINGAN KOD MATA PELAJARAN : BDC 4013/ BKM5073



Rajah S3



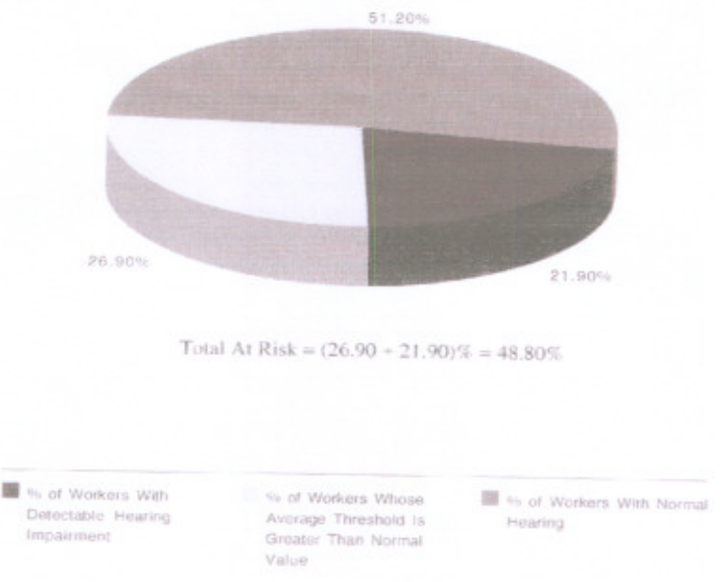
Audiograms showing different stages of noise induced hearing loss

Rajah S4(b)

PEPERIKSAAN AKHIR

SEMESTER/SESI : 1/2006/2007 KURSUS : 4 BDA/ 5 BKM

MATA PELAJARAN : GETARAN & KEBISINGAN KOD MATA PELAJARAN : BDC 4013/ BKM5073



Rajah S4(c)

Room or Space Acoustic Environment	Typical Range of $\bar{\alpha}$
Live	0.02 – 0.07
Fairly Live	0.07 – 0.15
Average	0.02 – 0.4
Fairly Dead	0.4 – 0.5
Dead (very unlikely in industrial environment)	0.5 – 0.8

Jadual S5

Sound Insulation

Transmission Loss

Panel construction	Thickness (mm)	Superficial weight (kg m^{-2})	Octave band center frequency (Hz) 63	125	250	500	1,000	2,000	4,000	8,000
20 g galvanized sheet steel	0.9	7	3	8	14	20	26	32	38	40
18 g galvanized sheet steel	1.2	10	8	13	20	24	29	33	39	44
16 g galvanized sheet steel	1.6	13	9	14	21	27	32	37	43	42
18 g fluted steel panels stiffened at edges, joints sealed	1.2	39	25	30	20	22	30	28	31	31
corrugated asbestos sheet, stiffened and sealed	6	10	20	25	30	33	33	38	39	42
chipboard sheets on wood framework	19	11	14	17	18	25	30	26	32	38
fiberboard on wood framework	12	4	10	12	16	20	24	30	31	36
plasterboard sheets on wood framework	9	7	9	15	20	24	29	32	35	38
ply wood sheets on wood framework	6	3.5	6	9	13	16	21	27	29	33
plywood sheets on wood framework	12	7	—	10	15	17	19	20	26	
hardwood (mahogany) panels	50	25	15	19	23	25	30	37	42	46
woodwork slabs, unplastered	25	19	0	0	2	6	6	8	8	10
woodwork slabs, plastered (12 mm on each face)	50	75	18	23	27	30	32	36	39	43
plywood	6	3.5	—	17	15	20	24	28	27	
plywood	18	10	—	24	22	27	28	25	27	
lead vinyl curtains	3	7.3	—	22	23	25	31	35	42	
lead vinyl curtains	2	4.9	—	15	19	21	28	33	37	
Panels of sandwich construction										
machine enclosure; panels 16 g steel + damping with 100 mm of glass-fiber, covered by 22 g perforated steel	100	25	20 25	21 27	27 31	38 41	48 51	58 60	67 65	66 66
as above, but 16 g steel	100	50	31	34	35	44	54	63	62	68

Sound Insulation

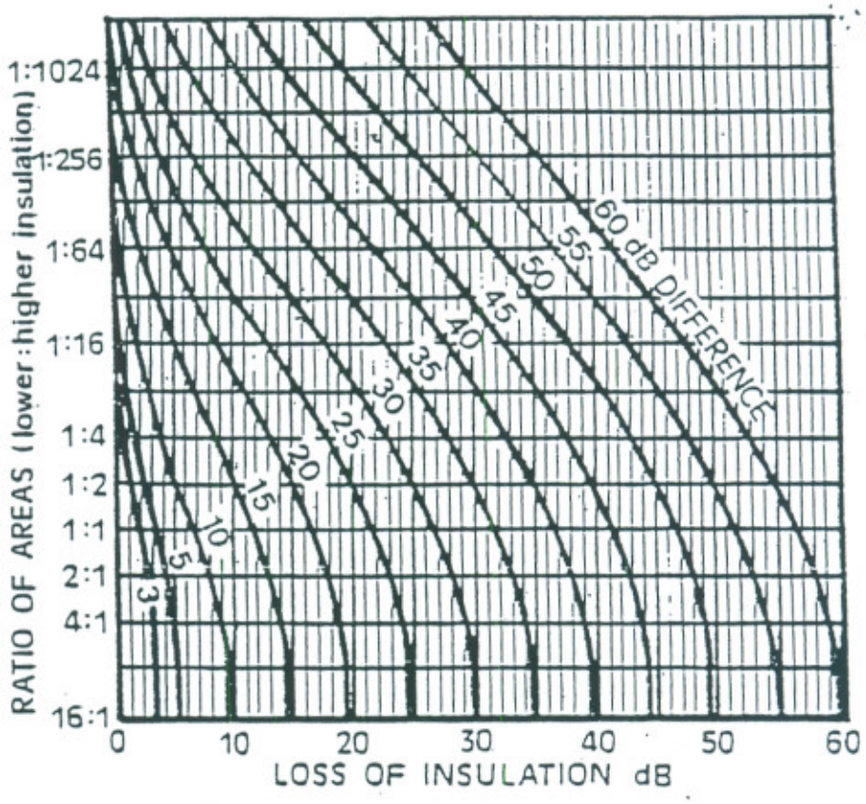
(*continued*).

Panel construction	Thickness (mm)	Superficial weight (kg m^{-2})	Octave band center frequency (Hz) 63	125	250	500	1,000	2,000	4,000	8,000
compressed straw between two sheets of 3 mm hardboard	56	25	15	22	23	27	27	35	35	38
Single masonry walls										
single leaf brick,	125	240	30	36	37	40	46	54	57	59
plastered both sides	255	480	34	41	45	48	56	65	69	72
	360	720	36	44	43	49	57	66	70	72
solid breeze or clinker, plastered (12 mm both sides)	125	145	20	27	33	40	50	58	56	59
solid breeze or clinker blocks, unplastered	75	85	12	17	18	20	24	30	38	41
hollow cinder concrete blocks, painted (cement base paint)	100	75	22	30	34	40	50	50	52	53
hollow cinder concrete blocks, unpainted	100	75	22	27	32	32	40	41	45	48
"Thermalite" blocks	100	125	20	27	31	39	45	53	38	62
glass bricks	200	510	25	30	35	40	49	49	43	45
plain brick	100	200		30	36	37	37	37	43	
Double masonry walls										
280 mm brick, 56 mm cavity, strip ties, outer faces plastered 12 mm	300	380	28	34	34	40	56	73	76	78
280 mm brick, 56 mm cavity, expanded metal ties, outer faces plastered 12 mm	300	380	27	27	43	55	66	77	85	85
Stud partitions										
50 mm × 100 mm studs, 12 mm insulating board both sides	125	19	12	16	22	28	38	50	52	55
50 mm × 100 mm studs, 9 mm plasterboard and 12 mm plaster coat both sides	142	60	20	25	28	34	47	39	50	56
Single glazed windows										
single glass in heavy	6	15	17	11	24	28	32	27	35	39
frame	8	20	18	18	25	31	32	28	36	39
	9	22.5	148	22	26	31	30	32	30	43

Sound Insulation

(*continued*).

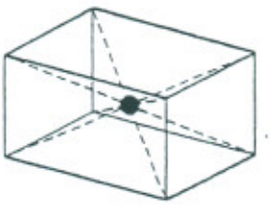
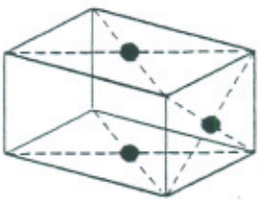
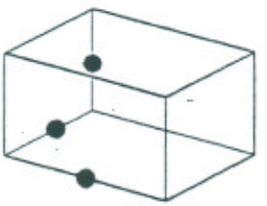
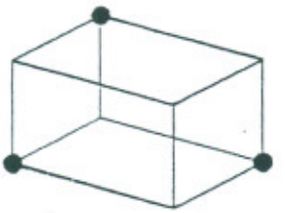
Panel construction	Thick-ness (mm)	Super-ficial weight (kg m^{-2})	Octave band center frequency (Hz)							
			63	125	250	500	1,000	2,000	4,000	8,000
	16	40	20	25	28	33	30	38	45	48
	25	62.5	25	27	31	30	33	43	48	53
laminated glass	13	32		23	31	38	40	47	52	57
Doubled glazed windows										
2.44 mm panes, 7 mm cavity	12	15	15	22	16	20	29	31	27	30
9 mm panes in separate frames, 50 mm cavity	62	34	18	25	29	34	41	45	53	50
6 mm glass panes in separate frames, 100 mm cavity	112	34	20	28	30	38	45	45	53	50
6 mm glass panes in separate frames, 188 mm cavity	200	34	25	30	35	41	48	50	56	56
6 mm glass panes in separate frames, 188 mm cavity with absorbent blanket in reveals	200	34	26	33	39	42	48	50	57	60
6 mm and 9 mm panes in separate frames, 200 mm cavity, absorbent blanket in reveals	215	42	27	36	45	58	59	55	66	70
3 mm plate glass, 55 mm cavity	63	25		13	25	35	44	49	43	
6 mm plate glass, 55 mm cavity	70	35		27	32	36	43	38	51	
6 mm and 5 mm glass, 100 mm cavity	112	34		27	37	45	56	56	60	
6 mm and 8 mm glass, 100 mm cavity	115	40		35	47	53	55	50	55	
Doors										
flush panel, hollow core, normal cracks as usually hung	43	9	0.9	12	13	14	16	18	24	26
solid hardwood, normal cracks as usually hung	43	28	13	17	21	26	29	31	34	32
typical proprietary "acoustic" door, double heavy sheet steel skin absorbent in air space, and seals in heavy steel	100	—	37	36	39	44	49	54	57	60



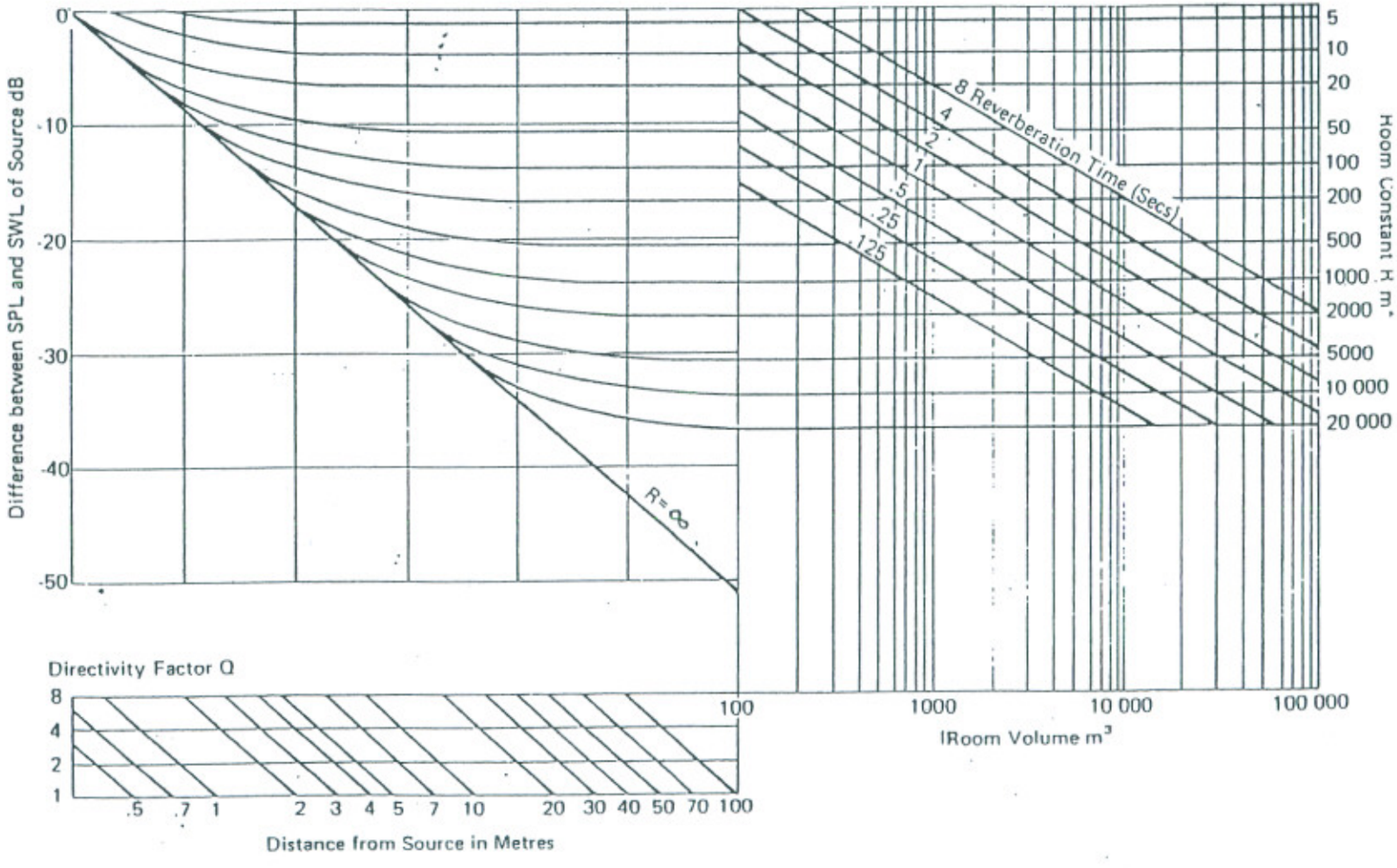
Nomogram for Determining the Overall Transmission Loss for a Composite Building Element.

Calculation Of Noise Levels

Directivity Factors

	Location	Directivity Factor, Q	dB to be Added
	Middle of Room in Mid–Air.	1	+ 0
	On the Middle of a Floor, Wall or Ceiling.	2	+ 3
	At the Edge in the Middle Between Two Edges.	4	+ 6
	At the Corner of the Room (ie at Corner of 3 edges).	8	+ 9

Calculation Chart For Estimating Sound Pressure Level In Enclosed Space



Fundamentals Of Noise

Graph for Addition of Two sources

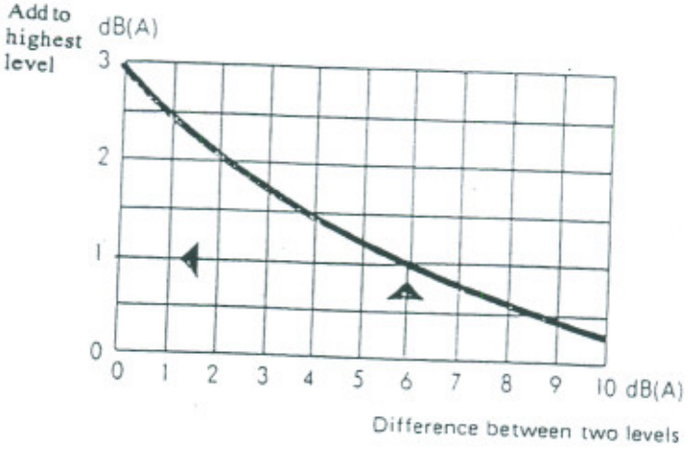


Table for Addition of Two Sources

If the levels differ by	The following should be added to the higher
0 or 1 dB	3 dB
2 or 3 dB	2 dB
4 to 9 dB	1 dB
10 dB or over	0 dB

Table for Subtraction of Two Sources

If the levels differ by	The difference is the higher level minus
More than 10 dB	0 dB
6 - 9 dB	1 dB
5 or 4 dB	2 dB
3 dB	3 dB
2 dB	5 dB (approx)
1 dB	7 dB (approx)

Noise Measurements

Values of Noise Rating Curves in dB (A)

Noise	Sound Pressure Levels dB (A)								
Rating	31.5	63	125	250	500	1000	2000	4000	8000
NR10	23	17	15	12	11	10	8	5	3
NR15	27	21	19	17	16	15	13	10	8
NR20	30	25	23	22	21	20	18	15	14
NR25	33	29	28	26	26	25	23	20	19
NR30	37	33	32	31	31	30	28	26	24
NR35	40	37	36	35	36	35	33	31	29
NR40	44	41	41	40	41	40	38	36	34
NR45	47	45	45	45	46	45	43	41	39
NR50	50	49	49	49	50	50	48	46	44
NR55	54	53	54	54	55	55	53	51	50
NR60	57	57	58	59	60	60	58	56	55
NR65	61	61	62	63	65	65	63	61	60
NR70	64	65	67	68	70	70	68	67	65
NR75	67	69	71	73	75	75	74	72	70
NR80	71	73	76	77	80	80	79	77	75
NR100	84	88	93	96	99	100	99	97	96
NR105	88	92	97	101	104	105	104	102	101
NR110	91	96	102	105	109	110	109	108	106
NR115	95	100	106	110	114	115	114	113	111