Contents

1 Tasks & Schedule for Summer 2007

Platform	Task	Assigned to	Progress
LabVIEW	Modularize Quizzing vi	Greg	✓
	Connect to database	Greg	✓
C++	Adopt PNL for Visual Studio 7	Michael	✓
	EM verification	Greg, Michael	
	Update class	Michael	
	Learning class	Michael	
	Frequentist1 implementation	Michael	
	Data log I/O	Michael	
MATLAB	Finish GraphIT visualization	Greg, Michael	
	GraphIT C++ log files	Michael	
PHP/APACHE	Integrate C++ and DB	Michael, Greg	
	Load student info class	Greg	
	Security issues	Greg	
	Remote Server test	Greg	
SQL	LabView Quizzing table	Greg	✓
	Vi objects specific table	Greg	

2 Visualization Tools: GraphIT

GraphIT is a MATLAB tool developed to provide a graphical simulation of the user model as predicted by the Bayesian Network
Programming conventions:

αD.GraphicalObject – object data where α refers to `upper(mfilename(1))` of class: *@class_name*
hGraphicalObject – handle of GraphicalObject, (ex. hAxes)

a	b
c	d

2.1 classes

2.1.1 @spfirst_obj

Private Data:

Object

Figure

Axes

form – {'button'} | 'note'

size

coord

tag

Methods:

spfirst_obj - constructor

get

set

move

2.1.2 @node

Private Data:

number

parents

children

Methods:

node - constructor

get

set

edit

2.2 Menu

2.2.1 File

Load LaTeX file – Loads a spfirst LaTeX chapter file (.tex) from its *GraphIT**Latex_DB_files*

Write DAG file – Writes a .txt DAG file for the loaded graph file

Figure Menu – Sets figure menu property 'MenuBar' to 'figure'; used for image copy

2.2.2 Graph

Create Graph – creates a graph

Build Graph

Load Graph

Save Graph

Clear Graph

3 Software Implementation

3.1 PNL

4 ITS Architecture

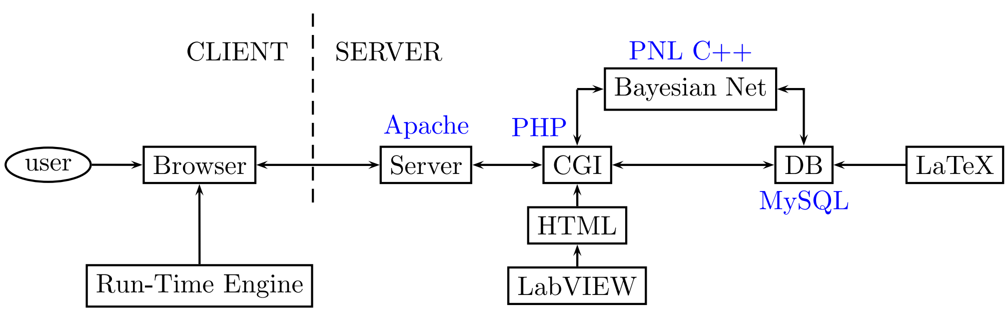

Figure 1: ITS Software Implementation: Client/Server Model

5 ITS Database Structure

The first set of tables describes users, ITS state, and the concepts and questions which the user has already seen. Tables USER_STATE and STATISTICS are *dynamic*, since they will be updated as the user progresses through the questions.

* primary key
† foreign key

USERS table: (System: Who has access to ITS? - list of all users)

id*	**first_name**	**last_name**	**username**	**password**	**status**	**lab[N]**
909999999	John	Smith	gtg999x	gtg999x	admin	02-02-09, 4:14 pm
909911111	GT	Buzz	gtg111z	gtg111z	Spring_2009	02-14-09, 2:45 pm

STATS_[id] table: (Statistical record of user actions)

id	**question_id**†	**concept_id** †	**current_chapter**	**answered**	**score**
1	60234	70001	7	B	100

rating	**comment**	**tags**†
3	This question is confusing!!	fourier,convolution

CPT_[id] table: (Conditional Probability Table for each chapter's node)

node_id	**prob**$_n$	**prob**$_{n+1}$	**...**
1.1	0.5	0.5	...

The second set of tables consists of a knowledge repository populated with chapter questions, where the structure of the corresponding dependency maps is embedded in these tables. All of these tables are *static*, as they will not update with user actions.

QUESTION table:

id*	**concept_id** †	**question_file**	**answer_file**	**format**	**solution**	**tags**†
60234	FIR:output	q60234.tex	a60234.tex	MC	B	convolution,system

CONCEPT table:

id*	**name**	**chapter_number**	**concept_file**	**book_ref**	**parents**
6003	FIR:output	6	FIR_output.tex	(6.5)	FIR:FR, CE:signal:discrete, frequency:DT[4]

CONCEPT_SYNONYMS table:

id*	**synonyms***
2028	Euler's Formula

LABVIEW table:

concept_id*	**gui_name**
7012	SineDrill

The third set of tables stores WebCT questions according to their type, where:
S – short answer, M – matching, P – paragraph, C – calculated, MC – multiple choice

WEBCT table:

id*	qtype †	title	image	question	answers	category
1	MC	cos(t)	cos.jpeg	What is cos(0.5)?	3	Phase

WEBCT_C table:

id*	formula	val[i]	min_val[i]	max_val[i]
3	2*{x}	{x}	0	100

WEBCT_M table:

id*	L[i]	R[i]

WEBCT_MC table:

id*	feedback	weight[i]	answer[i]	reason[i]
5	Try harder	100	x=7	x > 0

WEBCT_P table:

id*	template	answer
7012	What is sin(0)?	sin(0) = 0

WEBCT_S table:

id*	ans[i]
7	z=1

5.1 Bayesian Net

- OpenPNL - INTEL's open source Probabilistic Networks Library
- Written in C++ and modeled on Kevin Murphy's Bayesian Net Toolbox
- www.intel.com/technology/computing/pnl/

We are in the very final stages of implementing the Expectation-Maximization (EM) algorithm with one observed node per update. Currently our algorithm retains all past evidences and chooses the next concept based on the lowest marginal probability of either parent nodes (if student fails) or children nodes (if student passes). In the case where no parent (child) node exists, the algorithm chooses the lowest marginal probability globally, within its chapter concepts. The algorithm terminates when the marginal probability of all concepts reaches a designated threshold.

5.2 Concept Questions

- Concept questions have been specifically structured to deal with only one concept.
- Question's concept dependencies are dictated by the belief network.
- They are formatted as either 'Matching','Multiple Choice', or 'Calculated' questions.

5.3 LabVIEW Modules

5.3.1 Installation

5.3.2 DB connectivity

LabVIEW connects to the MySQL database using LabSQL ADO functions.

1. Get question ID from *user_state* table:
   `SELECT question_id FROM user_state;`
2. Get question's concept ID from *question* table:
   `SELECT concept_id FROM question WHERE id = 70090;`
3. Get GUI name to display from *labview* table:
   `SELECT gui_name FROM labview WHERE concept_id = 7015;`
4. Get user ID from *user_state* table:
   `SELECT user_id FROM user_state;`
5. Set corrrect answer to *question* table:
   `UPDATE question SET solution = 'D' WHERE id = 70090;`
6. Set student answer to *statistics* table:
   `UPDATE statistics SET answered = 'C' WHERE user_id = 111111111;`

Grading will be performed in the PHP script Grading.php.

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6 Software Installation

Module	Software	Ver	Notes
Server	Apache	2.0.55	http://httpd.apache.org/download.cgi
Database	MySQL	5.0.21	http://dev.mysql.com/downloads/mysql/5.0.html#downloads
CGI CGI-Apps CGI-DB CGI-Table	PHP PHP PEAR PHP PEAR::MDB2 MDB2_Driver_mysql Structures/Datagrid /Renderer/CVS /Renderer/HTMLTable	5.1.2	http://www.php.net/downloads.php http://pear.php.net http://pear.php.net/package/MDB2/ http://pear.php.net/manual/en/package.structures.structures-datagrid.php
Math	MATLAB	R2007a	
Renderer	LaTeX		http://www.forkosh.dreamhost.com/source_mimetexmanual.html
GUI	LabVIEW	8.6	
Bayes Net	PNL	1.0	https://sourceforge.net/projects/openpnl/
C++ to DB	mySQL++		http://tangentsoft.net/mysql++/

6.1 On LINUX

7 Knowledge Domain

	CONCEPT	FORMULA	COMMENT	SYNONYM	UNITS	BOOK REF	PARENTS
Chapter 1: Introduction							
1.1	signal		carries information	waveform		[1-1]	
1.2	system		operates on signals to produce new signals			[5-1]	signal
1.3	signal:CT	$s(t)$		signal:analog			signal
1.4	sampling	$s[n] = s(nT_s) \quad n \epsilon \mathbb{Z}$		C-D converter			signal:CT
1.5	sampling:period	T_s					sampling
1.6	signal:DT	$s[n] = s(nT_s) \quad n \epsilon \mathbb{Z}$				[1-2]	signal:CT sampling
1.7	signal:CT:image	$p(x, y)$				[1-3]	signal:CT
1.8	signal:DT:image	$p[m, n] = p(m\triangle_x, n\triangle_y) \quad m, n \epsilon \mathbb{Z}$				[1-3]	signal:CT:image signal:DT
1.9	signal:CT:video	$v(x, y, t)$					signal:CT:image
1.10	system:CT	$y(t) = \tau\{x(t)\}$				(1.1)[1-5]	system signal:CT
1.11	system:DT	$y[n] = \tau\{x[n]\}$					system signal:DT
1.12	block diagram		visual representation of the system			[1-5]	system
Chapter 2: Sinusoids							
2.1	sin	$\sin(\theta) = \frac{y}{r} \quad y = r\sin(\theta)$				[2-4]	
2.2	cos	$\cos(\theta) = \frac{x}{r} \quad y = r\cos(\theta)$				[2-4]	
2.3	sin:props					{2-1}	sin cos
2.4	cos:props					{2-1}	sin cos
2.5	sin:derivative	$\frac{d\sin(\theta)}{d\theta} = \cos(\theta)$					sin cos
2.6	cos:derivative	$\frac{d\cos(\theta)}{d\theta} = -\sin(\theta)$					sin cos
2.7	sine:identities					{2-2}	sin cos
2.8	cos:identities					{2-2}	sin cos
2.9	sinusoid	$x(t) = A\cos(\omega_o t + \phi)$		waveform		(2.1,2.2) [2-1]	sin cos signal[1]
2.10	sinusoid:amplitude	A					sinusoid
2.11	sinusoid:frequency:radian	$\omega_o = 2\pi f_o = 2\pi/T_o$			rad/sec		sinusoid
2.12	sinusoid:frequency:cyclic	$f_o = \omega_o/2\pi$			$Hz = sec^{-1}$		sinusoid:frequency:radian
2.13	sinusoid:period	$T_o = 1/f_o$			sec	(2.4)	sinusoid:frequency:cyclic
2.14	sinusoid:phase	ϕ					sinusoid
2.15	sampling:period	T_s					sampling[1]
2.16	time-shift:CT	$x(t) : x(t - t_o)$					signal:CT[1]
2.17	sinusoid:time-shift	$cos(\omega_o(t - t_1)) = cos(\omega_o - \phi) \quad \phi = -2\pi(\frac{t_1}{T_o})$		sinusoid:phase-shift		(2.7)	sinusoid:phase time-shift:CT
2.18	reducing mod2π	$mod(\phi, 2\pi)$					sinusoid:time-shift
2.19	principle value	$-\pi < \phi < \pi$					reducing mod2π

	CONCEPT	FORMULA	COMMENT	SYNONYM	UNITS	BOOK REF	PARENTS
2.20	complex plane	Domain $:= \Re e\{z\}$, Range $:= \Im m\{z\}$				[2-10]	
2.21	complex number:CF	$z = x + jy$					complex plane
2.22	complex number:PF	$z = re^{j\theta} = r\cos(\theta) + jr\sin(\theta)$				(2.11)[1-5]	complex number:CF
2.23	complex:CF:magnitude	$\|z\| = \sqrt{zz^*} = \sqrt{x^2 + y^2}$				(2.9)	complex number:CF
2.24	complex:CF:argument	$\angle\theta = \arctan(\frac{y}{x})$			radians	(2.9)	complex number:CF
2.25	complex:PF:magnitude	$\|z\| = r$					complex number:PF
2.26	complex:PF:argument	$\angle\theta = \theta$					complex number:PF
2.27	conjugate	$z^* = x - jy \quad , z^* = re^{-j\theta}$				A-4	complex number:CF complex number:PF
2.28	CE	$e^{j\theta} = \cos(\theta) + j\sin(\theta)$		Euler's formula		(2.10)	complex number:PF
2.29	CE:signal	$z(t) = Ae^{j\omega_o t + \phi} = Xe^{j\omega_o t}$				(2.12,2.16)	complex number:PF signal[1]
2.30	phasor	$X = Ae^{j\phi}$		complex amplitude		(2.15)	CE:signal
2.31	sin:CE	$\sin(\theta) = \frac{e^{j\theta} - e^{-j\theta}}{2j}$		inverse Euler's formula:sine		(2.17)	sin CE
2.32	cos:CE	$\cos(\theta) = \frac{e^{j\theta} + e^{-j\theta}}{2}$		inverse Euler's formula:cosine		(2.18)	cos CE
2.33	sinusoid:CE	$A\cos(\omega_o t + \phi) = A\frac{e^{j(\omega_o t + \phi)} + e^{-j(\omega_o t + \phi)}}{2}$					sinusoid CE
2.34	phasor:addition	$\sum_{k=1}^{N} A_k\cos(\omega_o t + \phi_k) = A\cos(\omega_o t + \phi)$				(2.19)	sinusoid CE
2.35	phasor:addition:CE	$\sum_{k=1}^{N} A_k e^{j\phi_k} = Ae^{j\phi}$				(2.22)	phasor phasor:addition

Chapter 3: Spectrum Representation

3.1	SS	$x(t) = A_o + \sum_{k=1}^{N} A_k\cos(2\pi f_k t + \phi_k)$				(3.1)	sinusoid[2]
3.2	SS:CE	$x(t) = X_o + \sum_{k=1}^{N} \Re e\{X_k e^{j2\pi f_k t}\}$				(3.2)	SS
		$= X_o + \sum_{k=1}^{N}\{\frac{X_k}{2}e^{j2\pi f_k t} + \frac{X_k^*}{2}e^{-j2\pi f_k t}\}$				(3.3)	CE[2]
3.3	FD	$(f_k, \frac{1}{2}X_k), (-f_k, \frac{1}{2}X_k^*)$ pairs	work with frequency-response and spectrum representation			(3.4)	SS:CE
3.4	FD:DC	$(0, X_0 = A_0)$					FD
3.5	spectrum:plot						FD
3.6	SS:beat note	$x(t) = \cos(2\pi f_1 t) + \cos(2\pi f_2 t) = 2\cos(2\pi f_\triangle t)\cos(2\pi f_c t)$ $f_1 = f_c - f_\triangle \quad and \quad f_2 = f_c + f_\triangle$				(3.10,3.11)	SS
3.7	beat note:center frequency	$f_c = \frac{1}{2}(f_1 + f_2)$					SS:beat note
3.8	beat note:deviation frequency	$f_\triangle = \frac{1}{2}(f_2 - f_1)$					SS:beat note
3.9	signal:AM	$x(t) = v(t)\cos(2\pi f_c t)$				(3.13)	SS:beat note
3.10	AM:carrier frequency	f_c					signal:AM
3.11	signal:periodic	$x(t + T_o) = x(t)$					signal[1]
3.12	signal:period:fundamental	$smallest \quad T_o$					signal:periodic
3.13	frequency:harmonic	$f_k = kf_o$					sinusoid:frequency:cyclic[2]
3.14	frequency:fundamental	$f_o = \frac{1}{T_o} \quad , f_o = \gcd\{f_k\} \quad , largest\ f_o : f_k = kf_o$					signal:period:fundamental frequency:harmonic
3.15	SS:harmonic	$x(t) = A_o + \sum_{k=1}^{N} A_k\cos(2\pi f_o t + \phi_k)$				(3.17)	SS

	CONCEPT	FORMULA	COMMENT	SYNONYM	UNITS	BOOK REF	PARENTS
3.16	SS:harmonic:CE	$x(t) = \sum_{k=-N}^{N} a_k e^{j2\pi k f_o t} = a_o + 2\Re e\{\sum_{k=1}^{N} a_k e^{j2\pi k f_o t}\}$				(3.18)	frequency:fundamental SS:harmonic SS:CE
3.17	FS:synthesis	$x(t) = \sum_{k=-\infty}^{\infty} a_k e^{j(2\pi/T_o)kt}$				(3.19)	SS:harmonic:CE
3.18	CS	$a_{-k} = a_k^*$					conjugate[2]
3.19	FS:synthesis:CS	$x(t) = A_o + \sum_{k=1}^{N} A_k \cos((2\pi/T_o)kt + \phi_k)$				(3.20)	FS:synthesis CS
3.20	FS:analysis	$a_k = \frac{1}{T_o} \int_0^{T_o} x(t) e^{-j(2\pi/T_o)kt} dt$		integral		(3.21)	FS:synthesis:CS orthognality property
3.21	FS:analysis:DC	$a_o = \frac{1}{T_o} \int_0^{T_o} x(t) dt$				(3.22)	FS:analysis FD:DC
3.22	orthognality property	$\int_0^{T_o} v_k(t) v_l^*(t) dt = \begin{cases} 0 & \text{if } k \neq l \\ T_o & \text{if } k = l \end{cases}$ $v_k(t) = e^{j(\frac{2\pi}{T_o} kt)}$				(3.25) (3.24)	
3.23	signal:periodic:square wave	$s(t) = \begin{cases} 1 & \text{for} 0 \leq t \leq \frac{1}{2} T_o \\ 0 & \text{for } \frac{1}{2} T_o \leq t \leq T_o \end{cases}$				(3.31)[3-15]	signal:periodic
3.24	signal:periodic:triangle wave	$x(t) = \begin{cases} 2t/T_o & \text{for } 0 \leq t \leq \frac{1}{2} T_o \\ 2(T_o - t)/T_o & \text{for} \frac{1}{2} T_o \leq t \leq T_o \end{cases}$				(3.31)[3-18]	signal:periodic
3.25	signal:FM	$x(t) = A \cos(\psi(t))$		chirp		(3.43)	signal[1] cos[2]
3.26	FM:angle function	$\psi(t) = 2\pi \mu t^2 + 2\pi F_o t + \phi$				(3.44)	signal:FM
3.27	FM:instantaneous frequency	$\omega_i(t) = \frac{d}{dt} \psi(t)$ $f_i(t) = \frac{1}{2\pi} \frac{d}{dt} \psi(t) = 2\mu t + f_o$			rads/sec Hz	(3.45) (3.46)	FM:angle function

Chapter 4: Sampling and Aliasing

	CONCEPT	FORMULA	COMMENT	SYNONYM	UNITS	BOOK REF	PARENTS
4.1	sampling:rate	$f_s = \frac{1}{T_s}$			samples/sec		sampling:period[1]
4.2	frequency:DT	$\hat{\omega} = \omega T_s = \frac{2\pi f}{f_s}$		radian:normalized	radians	(4.4)	sampling:period[1] sinusoid:frequency:radian[2]
4.3	sinusoid:DT	$x[n] = A \cos(\hat{\omega} t + \phi)$				(4.3)	frequency:DT sinusoid[1] sampling[1]
4.4	aliasing						shannon sampling theorem
4.5	principal alias	frequencies in $-\pi < \hat{\omega} \leq \pi$					aliasing
4.6	sinusoid:alias	$\hat{\omega}_o, \hat{\omega}_o + 2\pi l, 2\pi l - \hat{\omega}_o \quad l \epsilon \mathbb{Z}$				(4.8)	aliasing sinusoid:DT
4.7	shannon sampling theorem	$f_s > 2f_{max} \quad , 0 \leq f_k \leq f_{max}$					sampling:rate
4.8	nyquist rate	$2f_{max}$					shannon sampling theorem
4.9	D-C converter:sinusoid	$y(t) = y[n]\|_{n=f_s t} \quad -\infty < n < \infty$				(4.11)[4-6]	sampling:rate sinusoid:DT
4.10	frequency:analog	$\omega = \hat{\omega} f_s \quad -\frac{1}{2} f_s < \omega < \frac{1}{2} f_s$				(4.12)	frequency:DT
4.11	system:C-D-C					[4-7]	frequency:analog principal alias sinusoid:alias sampling[1] D-C converter
4.12	sampling:over-sampling	$f_s \gg 2f_{max}$					sampling:rate shannon sampling theorem
4.13	sampling:under-sampling	$f_s < 2f_{max}$ $-\phi$					sampling:rate nyquist rate

	CONCEPT	FORMULA	COMMENT	SYNONYM	UNITS	BOOK REF	PARENTS
4.14	D-C converter	$y(t) = \sum_{n=-\infty}^{\infty} y[n]p(t - nT_s)$				(4.19)	sampling[1]
4.15	D-C converter:pulse	$p(t)$					D-C converter
4.16	pulse:zero-order hold	$p(t) = \begin{cases} 1 & -\frac{1}{2}T_s < t \le\ frac12T_s \\ 0 & \text{otherwise} \end{cases}$				(4.20)	D-C converter
4.17	pulse:linear	$p(t) = \begin{cases} 1 - \lvert t \rvert / T_s & -T_s \le t \le\ T_s \\ 0 & \text{otherwise} \end{cases}$				(4.21)	D-C converter
4.18	pulse:cubic spline	$p(t) = 0$ for $t = \pm T_s, \pm 2T_s$					D-C converter
4.19	pulse:ideal bandlimited	$p(t) = \frac{\sin \frac{\pi}{T_s} t}{\frac{\pi}{T_s} t}$ for $-\infty < t < \infty$				(4.22)	D-C converter
4.20	signal:bandlimited	$x(t) = \sum_{k=0}^{N} A \cos(2\pi f_k t + \phi_k) \quad 0 \le f_k \le f_{max}$	sinusoids whose frequencies are limited to a ”band of frequencies”			(4.23/24)	SS[3]

Chapter 5: FIR Filters

	CONCEPT	FORMULA	COMMENT	SYNONYM	UNITS	BOOK REF	PARENTS
5.1	signal support	$y[n] \neq 0 \quad$ for some n					
5.2	difference equation	$y[n] = \frac{1}{N} \sum_{k=0}^{N} x[k]$				(5.1)	system:DT[1]
5.3	causal filter	$h[n] = 0 \quad \forall\, n < 0$	Filter that uses only present and past input values				system:DT[1]
5.4	causal running averager	$y[n] = \frac{1}{N} \sum_{k=0}^{N} x[n-k]$				(5.2)	difference equation causal filter
5.5	FIR:system	$y[n] = \sum_{k=0}^{M} b_k x[n-k]$				(5.3)	causal running averager
5.6	FIR:filter:order	M					FIR:system
5.7	FIR:filter:length	$L = M + 1$	number of filter coeffs				FIR:filter:order FIR:system
5.8	unit impulse	$\delta[n] = 1$ if $n = 1$		delta function		(5.6)	FL signal
5.9	FL signal	$x[n] = \sum_{k} x[k]\delta[n-k]$		discrete sequence			signal support
5.10	FIR:impulse response	$h[n] = \sum_{k=0}^{M} b_k \delta[n-k] = b_n$ for $n = 0, 1, \ldots M$				[5-8]	FL signal FIR:system unit impulse
5.11	delay system	$y[n] = x[n - n_o]$ delay by n_o				(5.9)	difference equation
5.12	conv:sum:finite	$y[n] = \sum_{k=0}^{M} h[k]x[n-k]$				(5.10)	FIR:impulse response FIR:system
5.13	block diagram:multiplier	$y[n] = \beta x[n]$				[5-12(a)]	block diagram[1]
5.14	block diagram:adder	$y[n] = x_1[n] + x_2[n]$				[5-12(b)]	block diagram[1]
5.15	block diagram:unit delay	$y[n] = x[n-1]$				[5-12(c)]	block diagram[1] delay system
5.16	FIR:block diagram					[5-13]	block diagram:multiplier block diagram:adder block diagram:unit delay
5.17	time invariance	$x[n - n_o] \mapsto y[n - n_o]$				(5.15)	delay system
5.18	linearity	If $x_1[n] \mapsto y_1[n]$ and $x_2[n] \mapsto y_2[n]$, then $x[n] = \alpha x_1[n] + \beta x_2[n] \mapsto y[n] = \alpha y_1[n] + \beta y_2[n]$		principle of superposition		(5.16)	
5.19	conv:sum	$y[n] = \sum_{l=-\infty}^{\infty} x[l]h[n-l] = x[n] * h[n]$				(5.23)	conv:sum:finite
5.20	LTI system	$y[n] = x[n] * h[n]$	system which is both linear and time-invariant				time invariance linearity conv:sum
5.21	conv:with impulse	$x[n] * \delta[n - n_o] = x[n - n_o]$				(5.24)	conv:sum

	CONCEPT	FORMULA	COMMENT	SYNONYM	UNITS	BOOK REF	PARENTS
5.22	conv:commutative Prop	$x[n] * h[n] = h[n] * x[n]$				(5.25)	conv:sum
5.23	conv:associative Prop	$(x_1[n] * x_2[n]) * x_3[n] = x_1[n] * (x_2[n] * x_3[n])$					conv:sum
5.24	LTI system:cascaded	$h[n] = h_1[n] * h_2[n]$				[5-19/20]	LTI system

	CONCEPT	FORMULA	COMMENT	SYNONYM	UNITS	BOOK REF	PARENTS
Chapter 6: Frequency Response of FIR filters							
6.1	CE:signal:discrete	$x[n] = Ae^{j\phi}e^{j\hat{\omega}n}$					frequency:DT[4] CE:signal[2]
6.2	FIR:FR	$H(e^{j\hat{\omega}}) = \sum_{k=0}^{M} b_k e^{-j\hat{\omega}k} = \sum_{k=0}^{M} h[k]e^{-j\hat{\omega}k}$				(6.4)	FIR:system[5] CE:signal:discrete
6.3	FIR:output	$y[n] = (A\lvert H(e^{j\hat{\omega}})\rvert) \cdot e^{j\angle(H(e^{j\hat{\omega}})+\phi)}e^{j\hat{\omega}n}$				(6.5)	FIR:FR CE:signal:discrete frequency:DT[4]
6.4	FIR:gain	$\lvert H(e^{j\hat{\omega}})\rvert$					FIR:output
6.5	FIR:FR:superposition	$y[n] = H(e^{j0})X_o + \sum_{k=1}^{N}(H(e^{j\hat{\omega}_k})\frac{X_k}{2}e^{j\hat{\omega}_k n} + H(e^{-j\hat{\omega}_k})\frac{X_k^*}{2}e^{-j\hat{\omega}_k n})$ $= H(e^{j0})X_o + \sum_{k=1}^{N}\lvert H(e^{j\hat{\omega}_k})\rvert\lvert X_k\rvert\cos(\hat{\omega}_k n + \angle X_k + \angle H(e^{j\hat{\omega}_k}))$				(6.7)	FIR:output sinusoid:sum:CE[3]
6.6	TD		work with sequences, difference equation and impulse response				
6.7	FIR:transient region		length of M samples (*order* of FIR system)				FIR:output FIR:filter:order[5]
6.8	FIR:steady-state region		output corresponding to unbounded region				FIR:output FL signal[5]
6.9	TD2FD	$h[n] = \sum_{k=0}^{M} b_k\delta[n-k] \leftrightarrow H(e^{j\hat{\omega}}) = \sum_{k=0}^{M} h[k]e^{-j\hat{\omega}k}$					TD FD[3] FIR:impulse response[5] FIR:FR
6.10	FIR:FR:periodicity		2π k periodic, $-\pi < \hat{\omega} \leq \pi$				FIR:FR frequency:DT[4]
6.11	FIR:FR:CS	$H(e^{-j\hat{\omega}}) = H^*(e^{j\hat{\omega}})$ $b_k = b_k^*$ and $h[k] = h^*[k]$				(6.16)	FIR:FR CS[3]
6.12	FIR:FR:delay system		linear phase				delay system[5]
6.13	FIR:FR:first-diff system		highpass filter				FIR:FR:delay system highpass filter
6.14	highpass filter		system emphasizing the higher frequencies (near $\hat{\omega} = \pi$) relative to lower frequencies				lowpass filter
6.15	lowpass filter		filter with magnitude response that suppress high frequencies of the input				
6.16	FIR:FR:cascade LTI system	$h_1[n] * h_2[n] \leftrightarrow H_1(e^{j\hat{\omega}})H_2(e^{j\hat{\omega}})$				(6.20)	TD2FD LTI system:cascaded[5]
6.17	FIR:FR:running-average filter	$H(e^{j\hat{\omega}}) = \frac{1}{L}\sum_{k=0}^{L-1} e^{-j\hat{\omega}k}$		L-point running averager			TD2FD causal running averager[5]
6.18	geometric series	$\sum_{k=0}^{L-1}\alpha^k = \frac{1-\alpha^L}{1-\alpha}$, where $(\alpha \neq 1)$				(6.23)	
6.19	dirichlet function	$D_L(e^{j\hat{\omega}}) = \frac{\sin(\frac{\hat{\omega}L}{2})}{L\sin(\frac{\hat{\omega}}{2})}$				(6.27)	FIR:FR:running-average filter geometric series
6.20	FIR:FR:plot						principle value[2] FIR:FR w2what
6.21	w2what	$\lvert\omega\rvert < \frac{\pi}{T_s} \rightarrow \lvert\hat{\omega}\rvert < \pi$					frequency:DT[4]

	CONCEPT	FORMULA	COMMENT	SYNONYM	UNITS	BOOK REF	PARENTS
Chapter 7: Z-Transforms							
7.1	ZD		work with z-transforms and poles and zeros				
7.2	ZT	$x[k]=\sum_{k=0}^{N}x[k]\delta[n-k]\rightarrow X(z)=\sum_{k=0}^{N}x[k]z^{-k}$				(7.2)	FL signal[5] ZD
7.3	inverse ZT	$X(z)\rightarrow x[n]$				(7.3)	ZT
7.4	ZT pair	$x[n]\leftrightarrow X(z)$					ZT inverse ZT
7.5	FIR:system function	$h[n]=\sum_{k=0}^{M}b_k\delta[n-k]\leftrightarrow H(z)=\sum_{k=0}^{M}b_kz^{-k}$				(7.7)	ZT FIR:impulse response[5]
7.6	ZT:superposition Prop	$\alpha x_1[n]+\beta x_2[n]\mapsto\alpha X_1(z)+\beta X_2(z)$				(7.9)	ZT
7.7	ZT:unit delay	$x[n-1]\mapsto z^{-1}X(z)$				(7.12)	ZT:delay Prop
7.8	ZT:delay Prop	$x[n-n_o]\mapsto z^{-n_o}X(z)$				(7.13)	ZT
7.9	ZT:multiplicative Prop	$h[n]=h_1[n]*h_2[n]\leftrightarrow H(z)=H_1(z)H_2(z)$					ZT LTI system:cascaded[5]
7.10	ZT:LTI system	$Y(z)=H(z)X(z)$				(7.19)	ZT LTI system[5]
7.11	FIR:cascade filters					[7-2]	FIR:system function ZT:multiplicative Prop
7.12	FIR:cascade system					[7-2]	FIR:cascade filters ZT:LTI system
7.13	FIR:deconv	$H_1(z)H_2(z)=1$		inverse filtering			poly factor FIR:cascade system
7.14	poly factor						
7.15	zeros	$B(z)=0$, where $H(z)=\frac{B(z)}{A(z)}$					poly factor FIR:system function
7.16	poles	$A(z)=0$, where $H(z)=\frac{B(z)}{A(z)}$					FIR:system function poly factor
7.17	z-plane					[7-4]	complex plane[2]
7.18	unit circle	$z=e^{j\omega}\quad,\lvert z\rvert=1$				[7-4]	z-plane Def:z
7.19	ZD2FD	$H(z)=\sum_{k=0}^{M}b_kz^{-k}\rightarrow H(e^{j\hat{\omega}})=\sum_{k=0}^{M}b_ke^{-j\hat{\omega}k}$					FIR:system function Def:z
7.20	Def:z	$z=e^{j\omega}$				(7.26)	FIR:system function
7.21	pole-zero plot					[7-5]	z-plane poles zeros unit circle
7.22	L-th roots of unity	$z^L=1$					Def:z
7.23	nulling filter	$H(z)=\sum_{k=0}^{L-1}z^{-k}=0$ at $\hat{\omega}=\frac{2\pi k}{L}$					zeros FIR:FR[6] L-th roots of unity
7.24	L-pt running filter	$H(z)=\sum_{k=0}^{L-1}z^{-k}=\prod_{k=1}^{L-1}(1-e^{\frac{j2\pi k}{L}}z^{-1})$					nulling filter lowpass filter[6] geometric series[6]
7.25	FIR:complex BPF	$H(z)=\prod_{k=1 k\neq k_o}^{L-1}(1-e^{\frac{j2\pi k}{L}}z^{-1})$					L-pt running filter
7.26	FIR:complex BPF:coeffs	$b_k=e^{\frac{j2\pi k_o k}{L}}$				(7.40)	FIR:complex BPF
7.27	FIR:real BPF	$b_k=\cos(2\pi k_o k)$ for $k=0,1,\ldots,L-1$					FIR:complex BPF
7.28	linear phase filter	$b_k=b_{M-k}\quad,k=0,1,\ldots M$					nulling filter

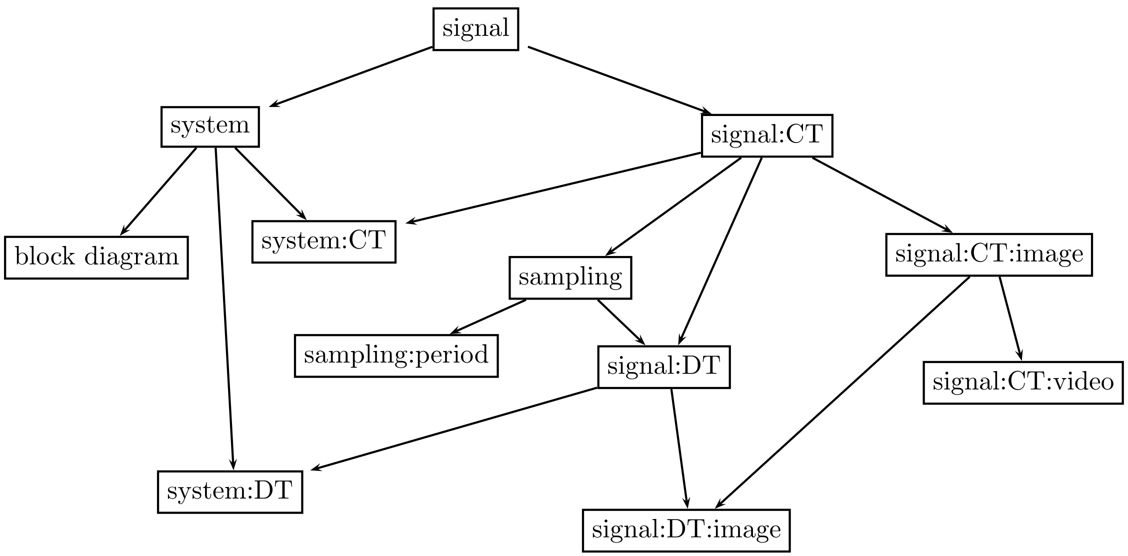
	CONCEPT	FORMULA	COMMENT	SYNONYM	UNITS	BOOK REF	PARENTS
7.29	linear phase filter:zeros	$H(z_o) = H(z_o^*) = H(\frac{1}{z_o}) = H(\frac{1}{z_o^*}) = 0$					linear phase filter

8 Acronyms

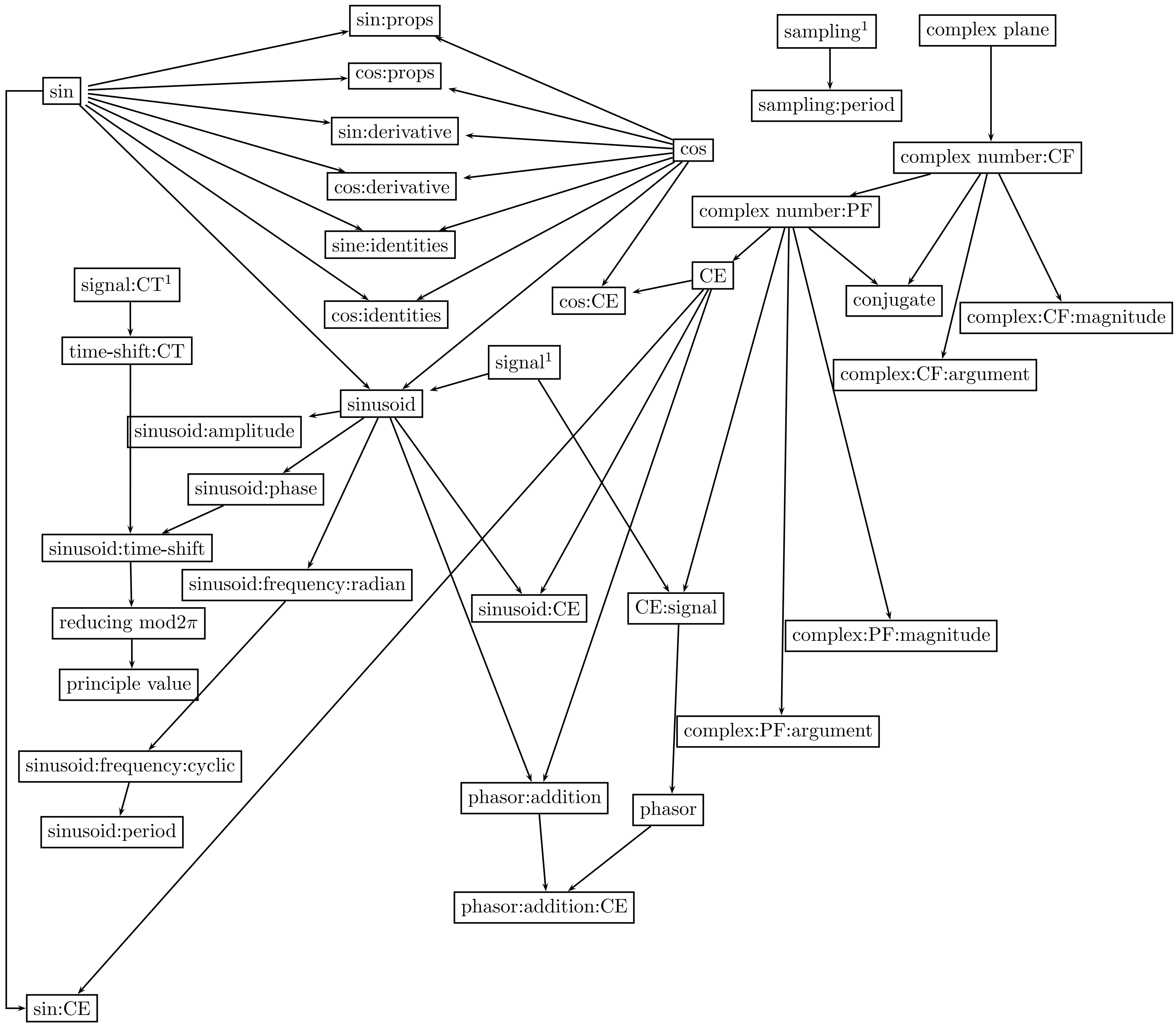
AM	amplitude modulation
CE	complex exponential
CF	cartesian form
CS	conjugate symmetric
CT	continuous time
DT	discrete time
FD	frequency domain
FM	frequency modulation
FR	frequency response
FS	fourier series
FD2ZD	frequency to z domain
PF	polar form
SS	sum of sinusoids
TD	time domain
ZT	z-transform
TD2FD	time to frequency domain
ZD2FD	z to frequency domain
PF	polar form
SS	sum of sinusoids
TD	time domain
ZT	z-transform
D-C	discrete to continuous
C-D-C	continuous to discrete
conv	convolution
deconv	deconvolution
first-diff	first-difference
props	property
ZD	z domain
coeffs	coefficients
mod	coefficients
Def	definition

9 Dependency Maps

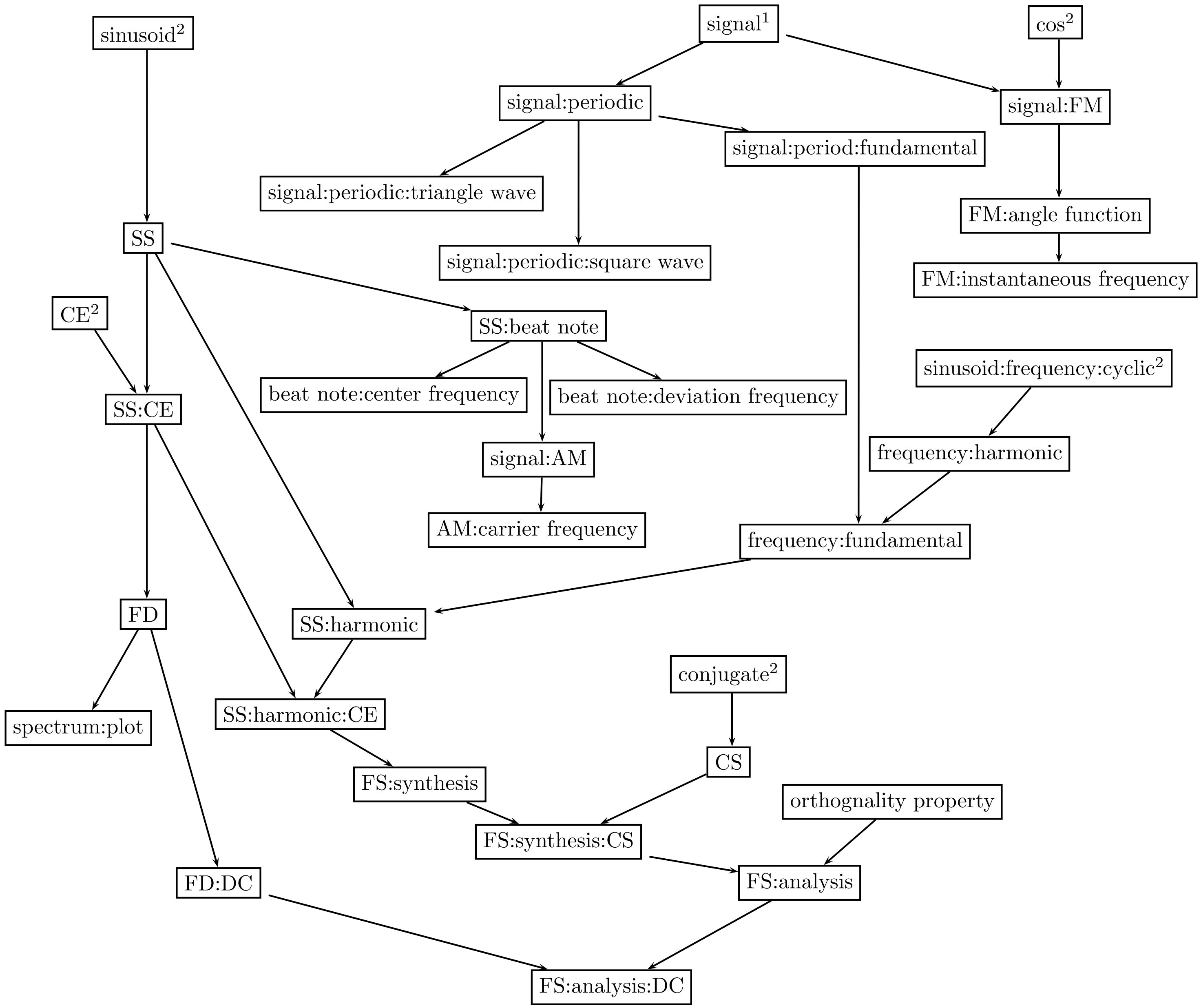
Chapter 1: Introduction



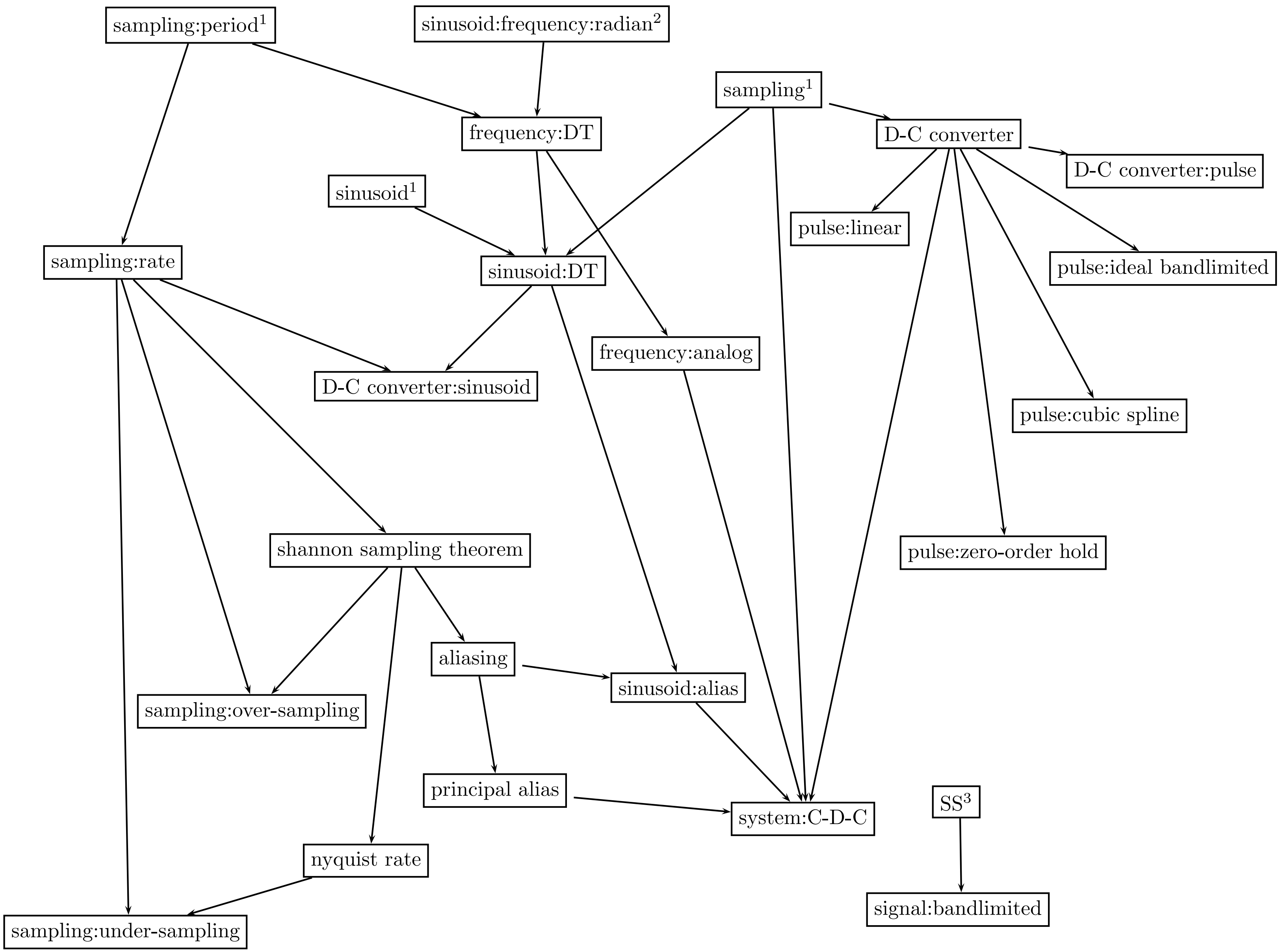
Chapter 2: Sinusoids



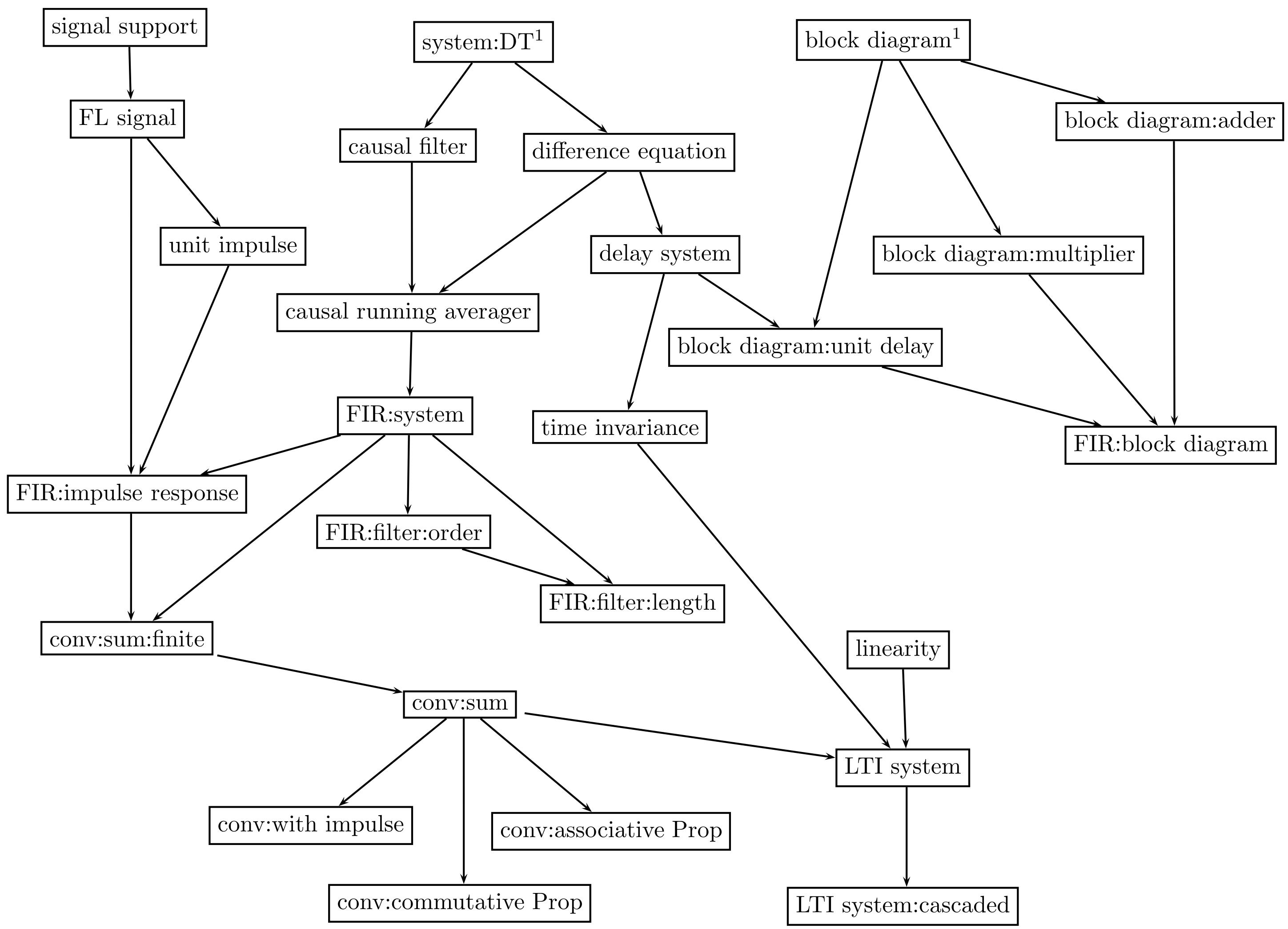
Chapter 3: Spectrum Representation



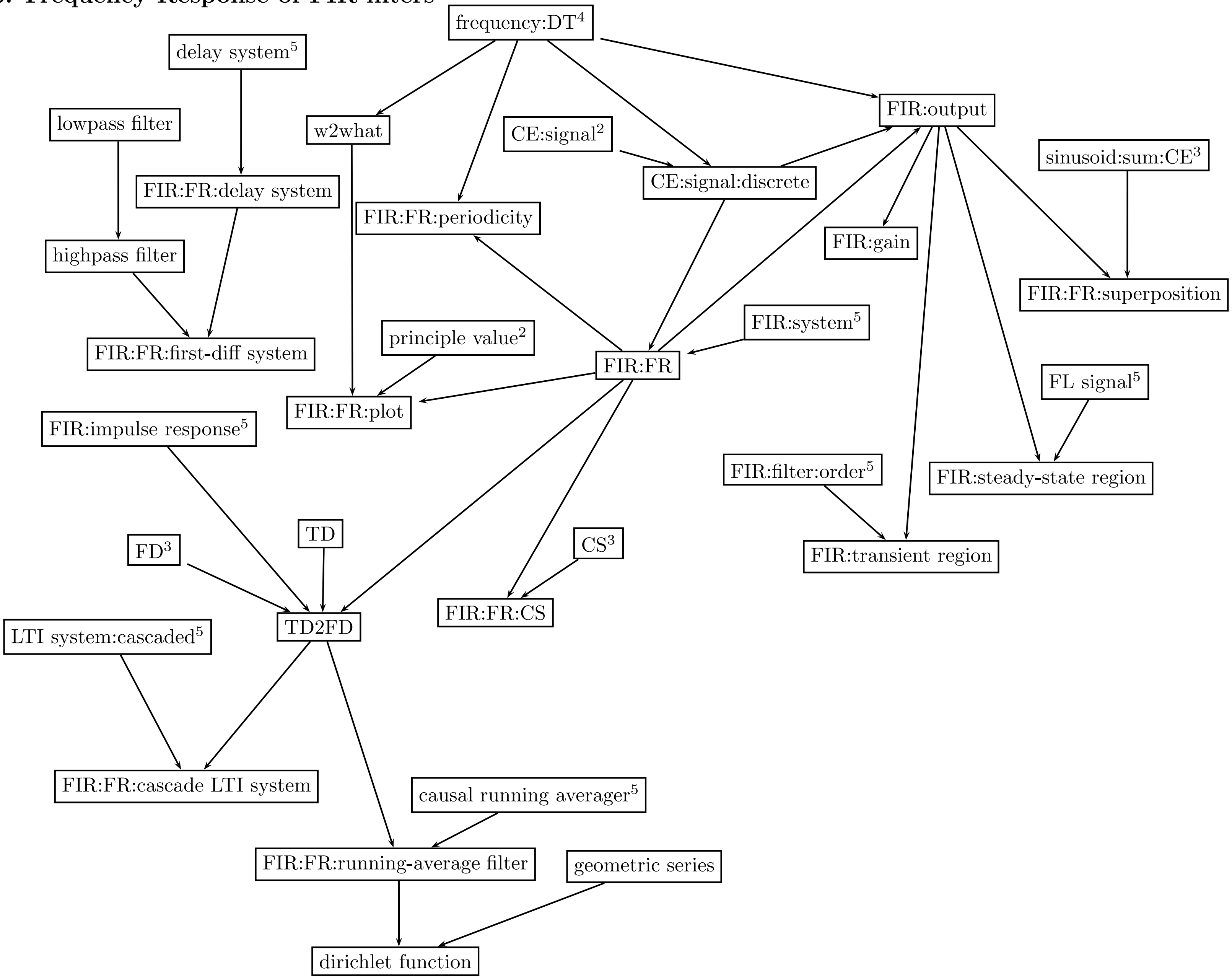
Chapter 4: Sampling and Aliasing



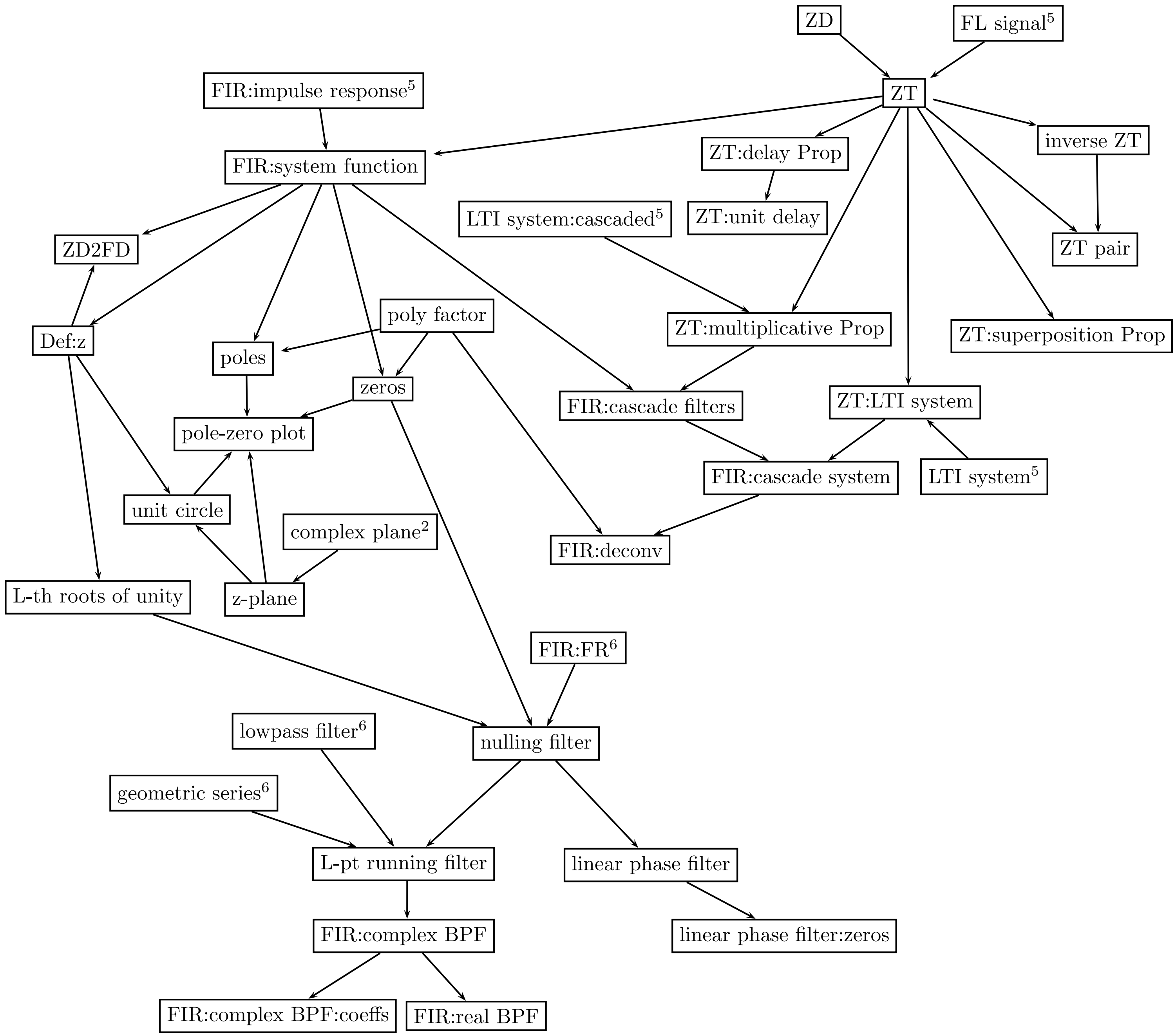
Chapter 5: FIR Filters



Chapter 6: Frequency Response of FIR filters



Chapter 7: Z-Transforms



10 Developers' Help Files

10.1 LaTeX

Rendering LaTeX questions:
`cd C:/Drive/ITS/its_main_v2p38/LatexQs`
`htlatex 7_1.tex "ITSconfig.cfg"`

10.2 PHP

10.2.1 Creating, Populating, and Deleting tables

System variables:

```
$doc_root = $\_SERVER['DOCUMENT\_ROOT'];
```

Form variables:

```
$student = $_POST['student'];
```

Include a file:

```
require($_SERVER['DOCUMENT_ROOT']."\its\login.html");
```

10.2.2 Creating, Populating, and Deleting tables

To load tables into MySQL type the following at the Command Prompt:
`mysql -u root -D its -p < tables.sql`

To load data into tables:
`mysql -u root -D its -p < test_case.sql`

To delete tables from the database, run the following script:
`mysql -u root -D its -p < deleteALL.sql`

Before dropping tables from a database, type the following to solve the foreign key constraint problem:
`SET FOREIGN_KEY_CHECKS = 0`

To backup a database into a file
`mysqldump --single-transaction --skip-add-locks -h babeldev.ece.gatech.edu ece2025 -u ece2025 -p > ITS_BAK.sql`

To backup a table from database into a file
`mysqldump its my_tab -u ece2025 -p > table_mytable.sql`
To alter table properties
`ALTER TABLE webct MODIFY id int(11) NOT NULL AUTO_INCREMENT`
To add a column to a table
`ALTER TABLE tb_name ADD col_name VARCHAR(60) AFTER col_name1`
To delete a column of a table
`ALTER TABLE tb_name DROP col_name;`

10.2.3 babeldev.ece.gateh.edu

mysql -h babeldev.ece.gatech.edu -u ece2025 -p

10.2.4 Error 1045- or when can not connect to mySQL user account

```
mysql> use mysql
mysql> SELECT Host, User, Password FROM user;
mysql> UPDATE user SET Host = 'localhost' WHERE User='root';
mysql> DELETE FROM user WHERE Host='other_hosts';
mysql> UPDATE user SET Password=Password('newpassword') WHERE User='root';
```

http://forums.mysql.com/read.php?35,9919,164372#msg-164372

10.3 LINUX

`/usr/sbin/gdmsetup`
Restart Apache: `apachectl restart`
Server (Apache) files: `/var/www/html/`

Start MySQL deamon: `./etc/rc.d/init.d/mysqld start` `/etc/init.d/httpd restart` `service httpd restart`
Firewall restart: `service iptables restart`
Check system path: `echo $PATH`

1. 1
2. yum install php-mysql*
3. yum install php-gd*
4. system-config-services
5. baobab (disk usage analyzer)
6. gnome-panel
7. gdmsetup
8. gnome-system-log
9. gnome-system-monitor

10.3.1 LOAD DATA LOCAL INFILE

On Windows server, it fails to read in a file into MySQL. Client (PHP) needs to pass data to Server (MySQL). Temp solution is to read file from `c:/php/`.

10.4 PEAR

---

pear config-show

```
c:\php> pear install pear
      > pear install --alldeps packagename [-beta]
      > pear upgrade pear
      > pear upgrade packagename
```

10.5 LabVIEW

---

1. Open the VI in LabVIEW.
2. Size the VI to the desired size by dragging the lower right corner.
3. Select the File > VI Properties menu item.

4. From the Category dropdown, select Execution.
5. Check the Run VI when opened check box.
6. From the Category dropdown, select Window Size.
7. Click the Set to Current Window Size button. Make note of the width and height, as this will need to be specified in the php document.
8. Click the OK button.
9. Save the VI by selecting the File > Save menu item.
10. Create a new project by selecting the File > New Project menu item.
11. LabVIEW should ask "There are currently VIs open ... Do you want to add them to the new project?" Select the option that adds the open VI to the project.
12. In the Project Explorer window, right click on Dependencies and choose Refresh from the list.
13. Save the project and all enclosed files by selecting the File > Save All menu item.
14. Right click on Build Specifications and choose New > Source Distribution.
15. In the My Source Distribution Properties window, change the Build Specification Name to the name of your VI.
16. In the Packaging Option section, select Custom.
17. Uncheck the Exclude vi.llb check box.
18. Uncheck the Exclude instr.llb check box.
19. Uncheck the Exclude user.llb check box.
20. Specify a Destination Path for your new .llb file.
21. Check the Destination is llb check box.
22. Confirm that the build is an LLB in the dialog that appears.
23. Click the Build button.
24. Save the project by selecting the File > Save All menu item.
25. Open the LabVIEW LLB Manager by selecting the Tools > LLB Manager menu item.
26. In the LLB Manager window, select the File > Open Folder menu item.
27. Navigate to the folder where your LLB is located and click the Current Folder button.
28. Double click your LLB in the list that appears.
29. Locate your VI in the list that appears, right click on it, and select the Top Level option.
30. Close the LLB Manager by selecting the File > Close menu item.
31. Close LabVIEW by selecting the File > Exit menu item.

10.5.1 LabVIEW - GUI

`C:/Drive/LabView/ITS/its_quiz7`

10.6 PNL

10.6.1 Compiling under Windows MS VC++ 6.0

In MS VC++ 6.0: Project ≫ Settings (Settings for "All Configurations")
C/C++ tab ≫ Category: Preprocessor

'Additional include directories':

```
C:\OpenPNL\PNL\c_pgmtk\include,
C:\OpenPNL\PNL\c_pgmtk\src\include,
C:\OpenPNL\PNL\cxcore\cxcore\include,C:\OpenPNL\PNL\bin
```

Link tab ≫ Category: Input
Add to 'Object/library modules'
pnld.lib cxcore.lib

'Additional library path':

```
C:\OpenPNL\PNL\lib,C:\OpenPNL\PNL\cxcore\lib
```

10.6.2 Compiling under Linux (gcc 4.1.2)

Set up an install directory for PNL, call it *pnl_install*

1. Give execute privileges: `chmod +x configure`
2. Under PNL dir: `.\configure.gcc --prefix=`*rootdir*`/pnl_install`
3. `make`
4. `.\configure --prefix=`*rootdir*`/pnl_install`
5. `make install`

try also:

```
./configure.gcc CXX=gcc4 CXXCPP=gcc4 --prefix=/export/home1/www/ece2025/pnl_install
```

10.7 LINUX

function	**Command**
zip folder	`zip -9 -r zipname foldername`
unzip *.tbz*	`tar -xjvf file.tbz`
unzip *.tar.gz*	`gzip -d file.tar.gz`
unzip *.tar*	`tar -xvf file.tar`
unzip *.tgz*	`tar -zxvf file.tgz`
check if packages installed	`rpm -q packagename`
where are packages installed	`whereis packagename`
	`locate packagename`
search file for a keyword	`grep 'keyword' file`
remove dir and all of its content	`rm -rf dirname`
search for keyword	`find / | grep 'keyword'`
apply a patch	`patch -p1 < patchname`
check disk space	`df -h`