Unit 305 High performance computer systems engineering

Unit summary

This unit is about current technologies and possible future trends in computer systems engineering.

Aims

To provide the candidate with the knowledge and understanding to appreciate the benefits of high performance parallel computing and its applications in science and engineering. It also aims to equip the candidate with an understanding of special purpose hardware and of the requirements for the reliability, safety and integrity of embedded systems particularly in safety critical applications.

Prerequisites

It is expected that candidates will have a working knowledge of computer systems engineering as exemplified by the Graduate Diploma examination Syllabus 9107-231 Computer systems engineering or a similar syllabus.

Learning outcomes

There are **four** outcomes to this unit. The candidate will be able to:

- Apply parallel computing techniques/systems
- Assess the performance of microprocessors in varying situations
- Chart the development of computer virtual environments
- Understand and operate real-time and embedded systems

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Guided learning hours

It is recommended that 300 hours should be allocated for this unit. 120 of those hours are actual taught hours. This may be on a full time or part time basis.

Key Skills

No Key Skills were identified for this unit.

Occupational Standards
This unit has been mapped to the following National Occupational Standards:

1.1.1 Identify the requirements of clients for engineering products or processes
1.1.2 Produce specifications for engineering products or processes
1.4.3 Create designs for engineering products or processes
1.4.4 Evaluate designs for engineering products or processes
2.1.1 Determine the production requirements of engineering products and processes
3.1.1 Determine the installation requirements for engineering products or processes
4.1.1 Determine the operational requirements of engineering products or processes
5.1.1 Determine the maintenance requirements of engineering products or procedures
6.2.1 Assure the quality of engineering products or processes
7.2.3 Evaluate projects
8.1.1 Maintain and develop own engineering expertise

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Outcome 1 Apply parallel computing techniques/systems

Knowledge requirements
The candidate knows how to:

1 relate the motivation for high performance and parallelism to
   a application areas
   b relevant technologies
2 function at abstraction levels
   a models of computation
   b overheads
   c multiple program counters
   d multi-threaded execution models
3 use
   a parallel languages and compilers
   b task-parallel programming models
   c data-parallel programming models
4 present experimentation results
5 evaluate memory architecture, memory access times and associated overheads
6 instigate performance turning
7 restructure for parallel performance
   a parallelising compilers
   b loop and data transformations
8 apply parallel algorithms
   a cyclic reduction
   b iterative and divide-and-conquer algorithms
   c adaptive quadrature
   d correct termination
9 investigate state of the art research and anticipate future directions

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Outcome 2 Assess the performance of microprocessors in varying situations

Knowledge requirements
The candidate knows how to:

1 investigate computer trends in technology with regard to
- a usage and costs
- b performance
- c benchmarks and benchmarking in respect to
  - i advances pipelining
  - ii dynamic scheduling
  - iii data hazards
  - iv static and dynamic branch prediction
  - v zero-cycle branches
  - vi multiple issue implementations

2 apply scaling and be conversant with scalability

3 implement superscalar compilation

4 recognise future technological implications, the market place and requirements for
- a mobile coding
- b JAVA implications
- c JIT compilation
- d dynamic optimisation

5 recognise and investigate the applications of digital signal processors in
- a communications
- b mobile phone developments
- c mobile computing
- d GPS

6 assess the role of microcontrollers in dedicated applications in
- a industry
- b commerce
- c the home

7 investigate processors for
   a image processing
   b graphics and animation
   c vision systems
   d neural networks
   e robotics
   f simulations
8 assess hardware in order to support fault tolerant computing
9 analyse concurrency and its implications for computer systems architecture
10 apply synchronisation methods
11 recognise the role of asynchronous processors for
   a high performance applications
   b low power applications
12 apply the ARM processor three and five stage pipelines and integer processor cores to specific and general cases
13 utilise architectural extensions for
   a floating point
   b DSP
14 manage memory hierarchy
15 analyse system-on-a-chip development

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Outcome 3 Chart the development of computer virtual environments

Knowledge requirements
The candidate knows how to:

1 trace the history and produce an overview of virtual environments
2 analyse 2D and volume virtual environments using reference models
3 analyse flow virtual environments
4 employ graphics hardware and software
5 interpolate and approximate
6 use systems utilising visual perception and colour
7 utilise basic and modal interaction
8 use and manage multidimensional data
9 assess virtual environments systems
10 assess animation systems
11 assess remove virtual environments
12 use advances user interfaces

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Outcome 4 Understand and operate real-time and embedded systems

Knowledge requirements
The candidate knows how to:

1 implement real-time and embedded systems

2 operate interface systems for complex industrial applications

- a timers and counters
- b signal multiplexing

3 operate mixed analog and digital systems

4 determine advanced sampling and data reconstructions

5 analyse real-time operating system kernels

6 manage

- a interupt task
- b clock task
- c base level task

7 determine exceptions and exception handling and develop techniques for managing overload under fault conditions

8 use

- a fail-soft techniques
- b high integrity systems

9 assess standards for safety critical systems

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Recommended reading list

Core texts	Author(s)	Publisher	ISBN
3D Computer Graphics	Watt	Addison Wesley	0201398559
ARM System-on-Chip Architecture	Furber	Addison Wesley	0201675196
Asynchronous Circuit Design	Myers	John Wiley & Sons Inc	047141543X
Asynchronous Digital Circuit Design	Birtwhistle, Davis	Springer-Verlag Berlin	3540199012
Computer Architecture: A Quantitative Approach	Hennessy, Patterson	Morgan Kaufmann	1558603298
Image Processing, Analysis and Machine Vision	Sonka et al	PWS Publishing	053495393x
Mobile Robotics: A Practical Introduction	Springer-Verlag UK	Springer-Verlag UK	1852331739
Multiprocessor Methods for Computer Graphics Rendering	Whitman	Jones and Bartlett	0867202297
Parallel Computer Architecture: A Hardware/Software Approach	Culler, Singh, Gupta	Morgan Kaufmann	1558603433
Scientific Visualisation, Advances and Challenges	Rosenbaum et al	IEEE Society Press & Academic Press This title is only available through IEEE directly	