**CMP3201 Embedded Systems**

Coursedescription

Almost every electronic appliance and device today uses embedded systems. Cell phones, automobiles, to asters, televisions, airplanes, medical equipment, and a host of other devices, products, and applications use embedded systems. Such systems include micro controllers, embedded programs, and real-time operating systems .These systems require a conscious effort to produce the most reliable product possible requiring the utmost diligence in system design and in design methodologies. Indeed, these design soften reflect the design of low power systems and tool support.

CourseObjectives

BycoveringthecourseinEmbeddedSystems,thestudentwillbeableto:

1.Identify some contributors to embedded systems and relate their achievements to the knowledgearea,describethemeaningofanembeddedsystem,explainthereasonsforthe importance of embedded systems, describe the relationship between programming languagesandembeddedsystemsanddescribehowcomputerengineeringusesorbenefits fromembeddedsystems.

2.Understand the CPU in the context of a complete system with I/O and memory, understandhowtheCPUtalkstotheoutsideworldthroughdevices,andunderstandhow memorysystemdesign(caches,memorymanagement)affect programdesignand performance.

3.Understand howhigh-level language programs convert intoexecutable code,knowthe capabilities andlimitsofcompilers, andcomprehend basicrepresentations ofprograms usedtomanipulateprogramseitherinacompilerorbyhand.

4.Distinguish RTOSs from workstation/server OS, distinguish real-time scheduling from traditionalOSscheduling,understandmajorreal-timeschedulingpoliciesandunderstand inter process communication mechanisms.

5.Understand why low-power computing is important, identify sources of energy consumptionandidentifypossibleremediesforenergyconsumptionat variouslevelsof designabstraction.

6.Understand the variety of sources of faults in embedded computing systems, identify strategiestofindproblemsandidentifystrategiestominimizetheeffectsofproblems.

7.Understandwhyreal-worldprojectsarenotthesameasclassprojects,identifyimportant goalsof themethodologyandunderstandtheimportanceof designtrackingand documentation.

8.Understand roleofhardware andsoftwaretoolsinsystemdevelopment andunderstand howtousetoolstosupportthemethodology.

9.Understand the use of multiple processors in embedded systems, identify trade-offs between CPUs and hardwired logic in multiprocessors, and understand basic design

techniques.

CourseContent

**HistoryandOverviewofEmbedded**

 Indicatesomereasonsforstudyingembeddedsystems

 Highlight somepeople thatinfluenced orcontributed totheareaofembedded systems

 Indicate some important topic areas such as mapping between language and hardware,classifications,influenceof softwareengineering,applicationsand techniques,andtoolsupport

 Contrastbetweenanembeddedsystemandothercomputersystems

 Mention the role of programming and its associated languages as applied to embeddedsystems

 Exploresomeadditionalresourcesassociatedwithembeddedsystems

 Explainthepurposeandroleofembeddedsystemsincomputerengineering

**EmbeddedMicrocontrollers**

 Structureofabasiccomputersystem:CPU,memory,I/Odevicesonabus

 CPUfamiliesusedinmicrocontrollers:4-bit,8-bit,16-32-bit

 BasicI/Odevices:timers/counters,GPIO,A/D,D/A

 PolledI/Ovs.interrupt-drivenI/O

 Interruptstructures:vectoredandprioritizedinterrupts

 DMAtransfers

 Memorymanagementunits

 Memoryhierarchiesandcaches

**EmbeddedPrograms**

 Theprogramtranslationprocess:compilation,assembly,linking

 Representationsofprograms:dataflowandcontrolflow

 Fundamental concepts of assembly language and linking: labels, address management

 Compilation tasks: mapping variables to memory, managing data structures, translatingcontrolstructures,andtranslatingexpressions

 Whatcanandcannotbecontrolledthroughthecompiler;whenwritingassembly languagemakessense

**Real-TimeOperatingSystems**

 Schedulingpolicies

 Rate-monotonicscheduling:theoryandpractice

 Priorityinversion

 OtherschedulingpoliciessuchasEDF

 Message-passingvs.sharedmemorycommunication

 Inter-processcommunicationstylessuchasmailboxandRPC

**Low-PowerComputing**

 Sourcesofenergyconsumption:toggling,leakage

 Instruction-levelstrategiesforpowermanagement:functionunitmanagement

 Memorysystempowerconsumption:caches,off-chipmemory

 Powerconsumptionwithmultipleprocesses

 System-levelpowermanagement:deterministic,probabilisticmethods

**ReliableSystemDesign**

 Transientvs.permanentfailuresinhardware

 Sourcesoferrorsfromsoftware

 Theroleofdesignverificationinreliablesystemdesign

 Fault-tolerancetechniques

 Famousfailuresofembeddedcomputers

**DesignMethodologies**

 Multi-persondesignprojects

 Designingon-timeandon-budget

 Designreviews

 Trackingerrorratesandsources

 Changemanagement

**ToolSupport**

 Compilersandprogrammingenvironments

 Logicanalyzers

 RTOStools

 Poweranalysis

 Softwaremanagementtools

 Projectmanagementtools

**EmbeddedMultiprocessors**

 Importanceofmultiprocessorsasinperformance,power,andcost

 Hardware/softwarepartitioningforsingle-bussystems

 Moregeneralarchitectures

 PlatformFPGAsasmultiprocessors

**NetworkedEmbeddedSystems**

 Whynetworkedembeddedsystems

 Examplenetworkedembeddedsystems:automobiles,factoryautomationsystems

 TheOSIreferencemodel

 Typesofnetworkfabrics

 Networkperformanceanalysis

 BasicprinciplesoftheInternetprotocol

 Internet-enabledembeddedsystems

**InterfacingandMixed-SignalSystems**

 Digital-to-analogconversion

 Analog-to-digitalconversion

 Howtopartitionanalog/digitalprocessingininterfaces

 Digitalprocessingandreal-timeconsiderations

Methodsofdelivery

ModesofAssessment

ReferenceMaterials

1. FrankVahidandTonyGivargis, 2002.EmbeddedSystemDesign:AUnified

*Hardware/ Software Introduction.* John Wiley & Sons; ISBN: 0471386782.

2. PeterMarwedel, 2006.EmbeddedSystemDesign.Birkhäuser, ISBN0387292373,

9780387292373

3. Arnold S. Berger, andArnold S. Berger, 2001. *Embedded SystemsDesign: An*

*IntroductiontoProcesses, ToolsandTechniques.CMPBooks*; 1stedition.ISBN-10:

1578200733,ISBN-13:978-1578200733

4. John Catsoulis, 2005. *Designing EmbeddedHardware*. 2ndEdition. O'Reilly Media, Inc. ISBN-10:0596007558. ISBN-13:978-0596007553.

5. TammyNoergaard,2005.*EmbeddedSystemsArchitecture:AComprehensiveGuidefor*

*EngineersandProgrammers.*Newnes.ISBN-10:0750677929.ISBN-13:978-

0750677929. Requirements

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| --- | --- | --- | --- | --- | --- |
| PeriodperWeek | ContactHourperSemester | WeightedTotalMark | WeightedExamMark | WeightedContinuousAssessmentMark | CreditUnits |

**ANNEX1 RESOURCESA)PERSONNEL**

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| --- | --- | --- | --- | --- | --- |
| No. | Name | Highest | Position | Dept./Faculty | Specialisation |
| 1 | S.S.Tickodri-Togboa | PhD | Prof. | Full-Time | ComputerEngineering,EngineeringMathematics |
| 2 | M.K Musaazi | PhD | Senior. Lecturer | Full-time | ElectricalEngineering,EngineeringMathematics |
| 3 | JBKirabira | PhD | SeniorLecturer | Full-Time | MechanicalEngineering |
| 4 | MAEOkure | PhD | AssocProf | Full-time | MechanicalEngineering |
| 5 | AdamSebbit | PhD | SeniorLecturer | Full-Time | MechanicalEngineering,EnergyEngineering, |
| 6 | Ms.D.Okello | PhD, | Lecturer | Full-Time | TelecommunicationsEngineering |
| 8 | L.L.Kaluuba | MSc | SeniorLecturer | Full-Time | ElectricalandTelecommunicationsEngineering |
| 9 | D.NsubugaMubiru | MSc | Lecturer | Full-Time | TelecommunicationsandElectronics |
| 10 | PIMusasizi | M.Sc. | Lecturer | Full-Time | ComputerSystemsEngineering |
| 16 | P.Lating-Okidi | M.Sc. | Lecturer | Part-Time | MechanicalEngineeringandICT |
| 18 | SKMwanje | MSc | AssistantLecturer | Full-Time | TelecommunicationsandElectricalEngineering |
| 19 | IGKMunabi | Msc | Assitantlecturer | Fulltime | Humananatomy |
| 20 | ESMwaka | PhD | Seniorlecturer | Fulltime | Humananatomy |
| 21 | CBIbingira | MMed | Seniorlecturer | Fulltime | Humananatomy |
| 22 | J Kasolo | Msc | Seniorlecturer | Fulltime | Physiology |
| 23 | PWaako | PhD | Seniorlecturer | Fulltime | Pharmacology |
| 24 | J Ochieng | Msc | Lecturer | Fulltime | Humananatomy |
| 25 | RLukande | MMed | Lecturer | Fulltime | Humanpathology |
| 26 | SLuboga | PhD | AssociateProf | Fulltime | HumanAnatomy |
| 27 | RBaingana | Msc | Seniorlecturer | Fulltime | Biochemistry |
| 28 |  |  |  |  |  |

**B. EQUIPMENTANDFACILITIES**

Physicalfacilities:

Theprogramwillusethefacilitiesthatexistwithintheschoolofbiomedicalsciencesandthe facultyoftechnology.

a)TheAnatomylecturetheatreforlectures,

b) TheHistologylaboratoryforpracticaldemonstrations,andlectures. c)TheAnatomydissectionsroomforprosectionsdemonstrations, d)Thephysiologylaboratoriesforpracticalphysiology

e)Davislecturetheatreforlecturesonsomeoccasions f)Anatomyseminarroom

g)Histologypreparationlaboratory h)Thebiochemistrylaboratory

i)Thereisadequatefurnitureinthedepartmentofhumananatomy j)Mechanicalandelectricalengineeringworkshops

k)Animalhouseforexperiments

l)Mulagohospitalengineeringdepartment

m)in the long term a biomedical engineering laboratory is planned in the school of biomedicalsciences

Specimensandteachingmaterial:

Thedepartmentofanatomyhascadavers,microscopicslides. Equipment:

Thedepartmentofhumananatomyhasmicroscopes,dissectionkits,andcomputers.Thereis equipmentinthebiomedicalsciencedepartmentsofphysiology,pathology,microbiology, pharmacology,biochemistry,pharmacy,physiotherapy,surgerymedicineradiologyanda computerlabwithrecommendedsoftwareforteachingbiomedicalengineersinthefacultyof technology. ThefollowingequipmentandfacilitiesareavailableandwillbeprovidedbytheFaculty:

 TelecommunicationsandElectronicsLabs,

 ICTlabsforundergraduatesandgraduates(witha totalofover150computersconnectedto the internetthroughFibre-Opticsnetworksystem(backbone)andhenceensuringfaculty-wide Internetconnectivity).

 Textbooks,TransportfacilitiesforfieldvisitsandIndustrialtraining,Facultylibrary,

 Lecturerooms.

 N.B.: ***Owingto thecharacteristicallyhands-on-natureoftheProgramme,studentswillbe verymuchencouragedto acquirepersonallap-topcomputers.Furthermore,becauseof the highrateofturn-outofliteratureinthisareaandtheratherlongtimetheprocessof acquiringliteraturethroughtheUniversityLibraryBook-banksystemoftentakes,students willbeadvisedtoadoptintensiveusageof internetresources.Occasionallythiswillrequire themtopurchasesomeofthemostcurrentpublicationsthatwillemergeduringtheirCourse asadditionaltext-books.***