University of Mumbai

No. AAMS_UGS/ICC/2022-23/ 131

CIRCULAR:-

Attention of the Principals of the Affiliated Colleges and Directors of the Recognized Institutions in Faculty of Science & Technology is invited to this office circular Nos. AAMS_UGS/ICC/2022-23/09 to 25 dated 4th May, 2022 relating to reduced for B.E. and No. AAMS_UGS/ICC/2022-23/156 dated 7th November, 2022 relating to introduced New Branch for B.E. (Computer Science & Design).

You are, hereby, informed that the arising out of discussion Point No. III passed by the Academic Council at its meeting held on 28th November, 2022 and that in accordance therewith, the syllabus reduced for Direct Second Year (Sem – III) students passed in the Academic Council Meeting dated 28th December, 2021 vide items no. 6.1 to 6.17 and circulated vide circular Nos. AAMS_UGS/ICC/2022-23/09 to 25 dated 4th May, 2022 be applicable as it is for the academic year 2022-23 only, for Direct Second Year (Sem – III) students for the following branches, as the admission for the first year are delayed due to Covid-19 Pandemic :

1. B.E. (Civil Engineering)
2. B.E. (Civil and Infrastructure Engineering)
3. B.E. (Bio-medical Engineering)
4. B.E. (Mechanical Engineering)
5. B.E. (Mechatronics Engineering)
6. B.E. (Automobile Engineering)
7. B.E. (Printing & Packaging Technology)
8. B.E. (Electronics Engineering)
9. B.E. (Electronics & Computer Science)
10. B.E. (Chemical Engineering)
11. B.E. (Information Technology)
12. B.E. (Electrical Engineering)
13. B.E. (Instrumentation Engineering)
14. B.E. (Production Engineering)
15. B.E. (Computer Engineering)
16. B.E. (Computer Engineering)
    1. (Artificial Intelligence and Data Science)
    2. (Artificial Intelligence and Machine Learning)
    3. (Cyber Security)
    4. (Internet of Things) (IOT)

5. (Data Engineering)
6. (Computer Science and Engineering) (Data Science)
7. (Computer Science and Engineering) (Artificial Intelligence and Machine Learning)
8. (Computer Science and Engineering) (Internet of Things and Cyber Security Including Block Chain Technology)

17. Electronics and Telecommunication Engineering

And for **B.E. (Computer Science and Design)** for Direct Second Year (Sem – *III*) students as per appendix for the academic year 2022-23 only, as the admission for the first year are delayed due to Covid-19 Pandemic.

The circular is available on the University's website www.mu.ac.in.

(Prof. Sunil Bhirud)
I/c Registrar

MUMBAI – 400 032
8th February, 2023

To

The Principals of the Affiliated Colleges and Directors of the Recognized Institutions in Faculty of Science & Technology.

A.C/Point No. III/28/11/2022

Copy forwarded with Compliments for information to :-

1) The Dean, Faculty of Science & Technology,
2) The Director, Board of Examinations and Evaluation,
3) The Director, Board of Students Development,
4) The Director, Department of Information & Communication Technology,
5) The Co-ordinator, MKCL.

AC – 28/11/2022
Point No. – III

University of Mumbai

Reduced Syllabus for
B.E.(Computer Science and Design)

Direct Second Year (Sem. III) Admitted Students for the Current Academic Year 2022-23 only

(Choice Based Credit System)

(With effect for the academic year 2022-23 only)

University of Mumbai

Syllabus for Approval

Sr. No.	Heading	Particulars
1	**Title of Course**	**B.E. (Computer Science and Design) (Sem. III)**
2	**Eligibility of Admission**	First Year Engineering
3	**Passing Marks**	40%
4	**Ordinances / Regulations (if any)**	
5	**No. of years/Semesters:**	4 Years / 8 Semesters
6	**Level:**	~~P.G.~~ / U.G./ ~~Diploma / Certificate~~ **(Strike out which is not applicable)**
7	**Pattern:**	~~Yearly~~ / Semester **(Strike out which is not applicable)**
8	**Status:**	~~Revised~~ / ~~New~~ / Reduced **(Strike out which is not applicable)**
9	**To be implemented from Academic Year :**	Direct Second Year (Sem. III) Admitted students for the current Academic year 2022-23 only.

Dr. Suresh K. Ukarande
Associate Dean,
Faculty of Science
and Technology

Dr. Shivram Garje
Dean,
Faculty of Science and
Technology

Program Structure for Second Year Semester
IIIUNIVERSITYOFMUMBAI(With Effectfrom2022-2023)

Course Code	CourseName	TeachingScheme (ContactHours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CSC301	Engineering Mathematics-III	3	--	1*	3	--	1	4
CSC302	DiscreteStructuresand GraphTheory	3		--	3		--	3
CSC303	DataStructure	3	--	--	3	--	--	3
CSC304	DigitalLogic& ComputerArchitecture	3	--	--	3	--	--	3
CSC305	ComputerGraphics	3	--	--	3	--	--	3
CSL301	DataStructureLab	--	2	--	--	1	--	1
CSL302	DigitalLogic& ComputerArchitecture Lab	--	2	--	--	1	--	1
CSL303	ComputerGraphics Lab	--	2	--	--	1	--	1
CSL304	Skill baseLabcourse: ObjectOriented ProgrammingwithJava	--	2+2*	--	--	2	--	2
CSM301	Mini Project–1 A		4$			2		2
Total		**15**	**14**	**1**	**15**	**07**	**1**	**23**

Course Code	CourseName	ExaminationScheme							
		Theory					Term Work	Pract & oral	Total
		Internal Assessment			End Sem. Exam	Exam. Duration (inHrs)			
		Test 1	Test 2	Avg					
CSC301	Engineering Mathematics-III	20	20	20	80	3	25	--	125
CSC302	DiscreteStructuresand GraphTheory	20	20	20	80	3	--	--	100
CSC303	DataStructure	20	20	20	80	3	--	--	100
CSC304	DigitalLogic& ComputerArchitecture	20	20	20	80	3	--	--	100
CSC305	ComputerGraphics	20	20	20	80	3	--	--	100
CSL301	DataStructureLab	--	--	--	--	--	25	25	50
CSL302	DigitalLogic& ComputerArchitLab	--	--	--	--	--	25	--	25
CSL303	ComputerGraphicsLab	--	--	--	--	--	25	25	50
CSL304	Skill baseLabcourse: ObjectOriented ProgrammingwithJava	--	--	--	--	--	50	25	75
CSM301	Mini Project–1 A						25	25	50
Total		**--**	**--**	**100**	**400**	**--**	**175**	**100**	**775**

*Should be conducted batch wise and$ indicates workload of Learner (Not Faculty), Studentscan form groups with minimum 2 (Two) and not more than 4 (Four),Faculty Load: 1 hourperweek perfour groups

CourseCode	CourseName	Credits
CSC301	EngineeringMathematics-III	4

Pre-requisite: EngineeringMathematics-I,EngineeringMathematics-II	
CourseObjectives: Thecourseaims:	
1	TolearntheLaplaceTransform, Inverse LaplaceTransformofvariousfunctions,itsapplications.
2	To understand the concept of Fourier Series, its complex form and enhance the problem-solvingskills.
3	Tounderstandtheconceptofcomplexvariables,C-Requationswithapplications.
4	Tounderstandthebasictechniquesofstatistics likecorrelation,regression,andcurvefittingfordata analysis,Machinelearning,and AI.
5	Tounderstandsomeadvancedtopicsofprobability, randomvariables withtheirdistributions and expectations.
CourseOutcomes: Onsuccessfulcompletion,ofcourse,learner/student will beableto:	
1	Understandthe concept ofLaplacetransformanditsapplicationtosolvetherealintegrals in engineeringproblems.
2	Understandthe conceptofinverseLaplacetransform ofvariousfunctionsanditsapplications in engineeringproblems.
3	Expandthe periodicfunctionbyusingthe Fourierseries forreal-lifeproblems and complex engineeringproblems.
4	Understandcomplex variabletheory,applicationofharmonicconjugatetoget orthogonaltrajectoriesandanalyticfunctions.
5	Applytheconceptof CorrelationandRegressiontotheengineeringproblems in datascience,machinelearning, andAI.
6	Understandthe conceptsofprobabilityandexpectationforgettingthespreadofthedataand distribution of probabilities.

Module	DetailedContents		Hours
1	**LaplaceTransform**		7
	1.1	DefinitionofLaplacetransform,ConditionofExistenceofLaplace transform.	
	1.2	LaplaceTransform(L)ofstandardfunctionslike $eat, sin(at), cos(at), sinh(at), cosh(at)$ and $tn, n \geq 0$.	
	1.3	PropertiesofLaplaceTransform: Linearity,FirstShiftingTheorem, SecondShiftingTheorem, ChangeofScale,Multiplication by*t*, Divisionby*t*,LaplaceTransform ofderivativesandintegrals (Propertieswithoutproof).	
	1.4	Evaluation ofrealimproperintegrals byusingLaplace Transformation.	
	1.5	**Self-learningTopics:** LaplaceTransform:Periodicfunctions, Heaviside"sUnitStepfunction,DiracDeltaFunction,Special	

		functions(ErrorandBessel)	

2	**InverseLaplaceTransform**		7
	2.1	DefinitionofInverseLaplaceTransform,Linearityproperty,Inverse LaplaceTransformofstandardfunctions, Inverse Laplacetransform usingderivatives.	
	2.2	PartialfractionsmethodtofindInverse Laplacetransform.	
	2.3	InverseLaplacetransform usingConvolutiontheorem(without proof)	
	2.4	**Self-learningTopics:**Applicationstosolveinitialandboundary valueproblemsinvolvingordinarydifferentialequations.	
3	**FourierSeries:**		7
	3.1	Dirichlet"sconditions,DefinitionofFourierseriesandParseval"s Identity(withoutproof).	
	3.2	Fourierseriesofperiodic function withperiod$2\pi$and$2l$.	
	3.3	Fourierseriesofevenandoddfunctions.	
	3.4	HalfrangeSineandCosineSeries.	
	3.5	**Self-learningTopics:**Orthogonalandorthonormalsetoffunctions, ComplexformofFourierSeries,FourierTransforms.	
4	**ComplexVariables:**		7
	4.1	Function*f(z)*ofcomplexvariable, Limit,Continuityand Differentiabilityof*f(z)*,Analyticfunction: Necessaryandsufficient conditionsfor*f(z)*tobeanalytic(without proof).	
	4.2	Cauchy-RiemannequationsinCartesiancoordinates(without proof).	
	4.3	Milne-Thomsonmethod:Determineanalyticfunction*f(z)*whenreal part(u), imaginarypart (v)oritscombination (u+v/ u-v)isgiven.	
	4.4	Harmonicfunction,HarmonicconjugateandOrthogonal trajectories.	
	4.5	**Self-learningTopics:**Conformalmapping, LinearandBilinear mappings,crossratio,fixedpointsandstandardtransformations.	
5	**StatisticalTechniques**		6
	5.1	KarlPearson"scoefficientofcorrelation(r)	
	5.2	Spearman"sRankcorrelationcoefficient(R)(withrepeatedandnon-repeatedranks)	
	5.3	Linesofregression	
	5.4	Fittingoffirst- andsecond-degreecurves.	
	5.5	**Self-learningTopics:**Covariance,fittingofexponentialcurve.	
6	**Probability**		6
	6.1	Definitionandbasicsofprobability, conditionalprobability.	
	6.2	TotalProbabilitytheoremandBayes"theorem.	
	6.3	Discreteandcontinuousrandom variablewithprobability distribution andprobabilitydensityfunction.	
	6.4	Expectation,Variance,Momentgeneratingfunction,Rawand centralmomentsup to4^{th}order.	
	6.5	**Self-learningTopics:**SkewnessandKurtosisofdistribution(data).	

References:	
1	HigherEngineeringMathematics,Dr.B.S.Grewal,KhannaPublication.
2	AdvancedEngineeringMathematics,ErwinKreyszig,WileyEasternLimited.

3	AdvancedEngineeringMathematics,R.K.JainandS.R.K. Iyengar,Narosa Publication.
4	ComplexVariablesandApplications,Brown and Churchill,McGraw-HillEducation.
5	Probability,StatisticsandRandomProcesses,T.Veerarajan,McGraw-HillEducation.
6	TheoryandProblemsofFourierAnalysiswithapplicationstoBVP,MurraySpiegel,Schaum"sOutlineSeries.

TermWork:	
GeneralInstructions:	
1	Batchwisetutorialshavetobe conducted. Thenumberof students perbatch will beasperUniversitypatternforpractical.
2	Studentsmustbeencouragedtowriteatleast6classtutorialsontheentiresyllabus.
3	A group of 4-6 students should be assigned a self-learning topic. Students should prepare apresentation/problem solving of 10-15 minutes. This will be considered as a mini project inEngineering Mathematics. This project will be graded out of 10 marks depending on theperformanceofthestudents.

ThedistributionofTermWork marks willbeasfollows:		
1	Attendance (TheoryandTutorial)	05marks
2	ClassTutorialsonentiresyllabus	10marks
3	Miniproject	10marks

<u>Assessment</u>:
InternalAssessmentTest:
Theassessmentconsistsoftwoclasstestsof20markseach.The1stclasstest(Internal AssessmentI)hastobeconductedwhenapproximately40%ofthesyllabusiscompleted.The 2nd classtesthastobeconducted(InternalAssessmentII)whenanadditional35%syllabusis completed.Theduration ofeachtest willbeforonehour.
EndSemesterTheoryExamination:

1	Thequestion paperwillcompriseatotalof 6 questions, each carrying20 marks.
2	Outofthe6questions, 4questions havetobeattempted.
3	Question1,basedontheentiresyllabus,willhave 4sub-questionsof5markseachandiscompulsory.
4	Question2toQuestion6will have3sub-questions,eachof6,6,and8marks,respectively.
5	Eachsub-question in(4)will befromdifferent modulesofthesyllabus.
6	Weightageof each modulewillbeproportional tothe numberoflecturehours,asmentioned in thesyllabus.

CourseCode	CourseName	Credits
CSC302	DiscreteStructuresandGraphTheory	3

Pre-requisite: BasicMathematics	
CourseObjectives: Thecourseaims:	
1	Cultivateclearthinkingandcreativeproblemsolving.
2	Thoroughlytrain in theconstructionandunderstandingofmathematical proofs. Exercisecommonmathematical arguments and proofstrategies.
3	Toapplygraphtheoryinsolvingpractical problems.
4	ThoroughlyprepareforthemathematicalaspectsofotherComputerEngineeringcourses
CourseOutcomes: Onsuccessfulcompletion,ofcourse,learner/student will beableto:	
1	Understandthenotionof mathematicalthinking,mathematicalproofs andtoapplytheminproblem solving.
2	Abilityto reasonlogically.
3	Abilitytounderstandrelations,functions,DiagraphandLattice.
4	Abilityto understandandapplyconcepts ofgraphtheoryinsolvingreal worldproblems.
5	Understanduseof groups andcodesinEncoding-Decoding
6	Analyze acomplexcomputingproblem andapplyprinciplesofdiscretemathematics toidentifysolutions

Module	DetailedContents		Hours
1	**Logic**		6
		PropositionalLogic,PredicateLogic,LawsofLogic,Quantifiers, NormalForms, Inference TheoryofPredicateCalculus,Mathematical Induction.	
2	**RelationsandFunctions**		**6**
	2.1	Basicconcepts ofSetTheory	
	2.2	**Relations:** Definition,TypesofRelations,RepresentationofRelations, ClosuresofRelations,Warshall"salgorithm,Equivalencerelationsand EquivalenceClasses	
	2.3	**Function**s:Definition,Typesoffunctions,Composition offunctions, IdentityandInversefunction	
3	**PosetsandLattice**		**5**
		PartialOrderRelations,Poset,HasseDiagram,ChainandAntichains, Lattice,TypesofLattice,Sublattice	
4	**Counting**		**6**
	4.1	BasicCountingPrinciple-SumRule,ProductRule, Inclusion-Exclusion Principle,PigeonholePrinciple	
	4.2	Recurrencerelations,Solvingrecurrencerelations	
5	**AlgebraicStructures**		**8**
	5.1	**Algebraicstructureswithonebinaryoperation:** Semi group,Monoid, Groups,Subgroups,AbelianGroup,Cyclicgroup,Isomorphism	
	5.2	**Algebraicstructureswithtwobinaryoperations:** Ring	
	5.3	**CodingTheory**:Coding,binaryinformationanderrordetection, decodinganderror correction	

6	**GraphTheory**		**8**
		Typesofgraphs,GraphRepresentation,Subgraphs,OperationsonGraphs, Walk, Path, Circuit, Connected Graphs, Disconnected Graph,Components, Homomorphism and Isomorphism of Graphs, Euler andHamiltonianGraphs,PlanarGraph,CutSet,CutVertex,Applications.	

Textbooks:	
1	BernadKolman,RobertBusby,SharonCutler Ross,Nadeem-ur-Rehman,"DiscreteMathematicalStructures",PearsonEducation.
2	C.L. Liu"ElementsofDiscreteMathematics",secondedition1985,McGraw-HillBookCompany.Reprinted 2000.
3	K.H.Rosen,"DiscreteMathematicsandapplications",fifthedition2003,TataMcGraw Hill PublishingCompany
References:	
1	YNSingh,"DiscreteMathematicalStructures", Wiley-India.
2	J.L.Mott,A.Kandel,T.P.Baker,"DiscreteMathematicsforComputerScientists andMathematicians",secondedition1986,PrenticeHallof India.
3	J.P.Trembley,R.Manohar"DiscreteMathematicalStructureswithApplicationstoComputerScience", TataMcGraw-Hill
4	SeymourLipschutz,MarcLarsLipson,"DiscreteMathematics"Schaum"sOutline,Mc Graw-Hill Education.
5	NarsingDeo,"GraphTheorywithapplicationstoengineeringandcomputerscience",PHI Publications.
6	P.K.Bisht,H.S.Dhami,"DiscreteMathematics",Oxfordpress.

Assessment:
InternalAssessmentTest:
Theassessmentconsistsoftwoclasstestsof20markseach.The 1 classtest(Internal AssessmentI)hastobeconductedwhenapproximately40%ofthesyllabusiscompleted.The 2nd classtesthastobeconducted(InternalAssessmentII)whenanadditional40%syllabusis completed.Theduration ofeachtest willbeforonehour.
EndSemesterTheoryExamination:

1	Thequestion paperwillcompriseatotalof 6 questions, each carrying20 marks.
2	Outofthe6questions, 4questions havetobeattempted.
3	Question1,basedontheentiresyllabus,willhave4sub-questionsof5markseachandiscompulsory.
4	Question2toQuestion6will have3sub-questions,eachof6,6,and8marks,respectively.
5	Eachsub-questionin(4)willbefromdifferentmodulesofthesyllabus.
6	Weightageof eachmodulewill beproportional tothe numberoflecturehours,asmentioned in thesyllabus.

UsefulLinks	
1	https://www.edx.org/learn/discrete-mathematics
2	https://www.coursera.org/specializations/discrete-mathematics
3	https://nptel.ac.in/courses/106/106/106106094/
4	https://swayam.gov.in/nd1_noc19_cs67/preview

CourseCode	CourseName	Credit
CSC303	DataStructure	03

Pre-requisite:CProgramming	
CourseObjectives: Thecourseaims:	
1	TounderstandtheneedandsignificanceofDatastructuresasacomputerProfessional.
2	Toteachconcept andimplementationoflinearandNonlineardatastructures.
3	Toanalyzevariousdatastructuresandselectthe appropriateonetosolve a specificreal-worldproblem.
4	Tointroducevarioustechniquesforrepresentation ofthedatainthereal world.
5	Toteachvarioussearchingtechniques.
CourseOutcomes:	
1	Studentswillbeabletoimplement Linearand Non-Lineardatastructures.
2	Studentswillbeabletohandlevariousoperationslikesearching,insertion,deletionandtraversalson various datastructures.
3	Studentswill beabletoexplainvariousdatastructures,relatedterminologies anditstypes.
4	Studentswillbeabletochooseappropriatedatastructureandapplyit tosolveproblemsin variousdomains.
5	Studentswill beabletoanalyzeandImplementappropriatesearchingtechniquesforagivenproblem.
6	Studentswillbe ableto demonstratetheabilitytoanalyze,design,applyand usedatastructuresto solveengineeringproblems and evaluate their solutions.

Module		DetailedContent	Hours
1		**IntroductiontoDataStructures**	**1**
	1.1	IntroductiontoDataStructures,Concept ofADT	
2		**Stack andQueues**	**4**
	2.1	Introduction,ADTofStack, ApplicationsofStack-Wellform-nessofParenthesis	
	2.2	IntroductionofDoubleEndedQueue,Applications ofQueue.	
3		**LinkedList**	**5**
	3.1	Introduction of Linked List v/s Array, Types of Linked List, Circular LinkedList, Doubly Linked List, Operations on Doubly Linked List, Stack andQueue using Singly Linked List, Singly Linked List Application-PolynomialRepresentation and Addition.	
4		**Trees**	**5**
	4.1	Introduction, Tree Operations on Binary Search Tree, Applications of BinaryTree,HuffmanEncoding,SearchTrees-AVL,rotationsinAVLTree,operationson AVLTree,Introduction of BTree,B+Tree.	
5		**Graphs**	**3**

	5.1	IntroductionofGraphTerminologies ,GraphTraversals-DepthFirstSearch(DFS)andBreadthFirstSearch(BFS),GraphApplication-TopologicalSorting.	
6		**SearchingTechniques**	**2**
	6.1	Hashing-Concept,HashFunctions,CollisionresolutionTechniques	

Textbooks:	
1	AaronMTenenbaum,YedidyahLangsam,MosheJAugenstein,"DataStructuresUsingC",Pearson Publication.
2	ReemaThareja,"DataStructuresusingC",OxfordPress.
3	RichardF.GilbergandBehrouzA.Forouzan, "DataStructures:APseudocodeApproach withC", 2nd Edition,CENGAGELearning.
4	JeanPaulTremblay,P.G.Sorenson,"IntroductiontoDataStructureand ItsApplications",McGraw-HillHigherEducation
5	DataStructuresUsingC,ISRDGroup,2 Edition,TataMcGraw-Hill.
References:	
1	Prof.P.S.Deshpande,Prof.O.G.Kakde,"Cand DataStructures",DreamTechpress.
2	E.Balagurusamy,"DataStructureUsingC",TataMcGraw-HillEducationIndia.
3	RajeshKShukla,"DataStructuresusingCandC++",Wiley-India
4	GAVPAI,"DataStructures",Schaum"sOutlines.
5	RobertKruse,C. L.Tondo,BruceLeung,"DataStructuresandProgramDesigninC", PearsonEdition

Assessment:	
InternalAssessment:	
Assessmentconsists oftwoclasstestsof20markseach.Thefirstclasstestistobeconducted whenapprox.40%syllabusiscompletedandsecondclasstestwhenadditional40%syllabusiscompleted.Duration ofeach test shall be onehour.	
EndSemesterTheoryExamination:	
1	Questionpaperwill consist of6questions,eachcarrying20marks.
2	Thestudents needtosolveatotal of4 questions.
3	QuestionNo.1willbecompulsoryand basedontheentiresyllabus.
4	Remainingquestion(Q.2toQ.6)will beselectedfromall themodules.

UsefulLinks	
1	https://nptel.ac.in/courses/106/102/106102064/
2	https://www.coursera.org/specializations/data-structures-algorithms
3	https://www.edx.org/course/data-structures-fundamentals
4	https://swayam.gov.in/nd1_noc19_cs67/preview

CourseCode	CourseName	Credit
CSC304	DigitalLogic&ComputerOrganizationandArchitecture	3

Pre-requisite: Knowledgeonnumbersystems	
CourseObjective:	
1	Tohavetherough understandingofthebasicstructureandoperationofbasic digitalcircuitsand digital computer.
2	Todiscussindetailarithmeticoperationsindigital system.
3	Todiscussgeneration ofcontrolsignalsanddifferentwaysofcommunicationwithI/Odevices.
4	Tostudythe hierarchicalmemoryandprinciplesofadvancedcomputing.
CourseOutcome:	
1	Tolearndifferentnumbersystemsandbasicstructureofcomputersystem.
2	Todemonstratethearithmeticalgorithms.
3	Tounderstandthebasicconcepts ofdigitalcomponents andprocessororganization.
4	Tounderstandthegeneration ofcontrolsignals of computer.
5	Todemonstrate thememoryorganization.
6	Todescribethe concepts ofparallelprocessinganddifferentBuses.

Module		DetailedContent	Hours
1		**ComputerFundamentals**	**2**
	1.1	Overviewofcomputerorganizationandarchitecture.	
	1.2	BasicOrganizationofComputerandBlockLevelfunctionalUnits,Von-NeumannModel.	
2		**DataRepresentation andArithmeticalgorithms**	**4**
	2.2	BoothsMultiplicationAlgorithm,Restoringand Non-restoringDivision Algorithm.	
	2.3	IEEE-754FloatingpointRepresentation.	
3		**ProcessorOrganizationandArchitecture**	**3**
	3.1	IntroductiontoFlipFlop	
	3.3	RegisterOrganization, InstructionFormats,Addressingmodes,Instruction Cycle, Interpretationandsequencing.	
4		**ControlUnitDesign**	**5**
	4.1	HardwiredControlUnit:StateTableMethod,DelayElementMethods.	
	4.2	MicroprogrammedControlUnit:MicroInstruction-Format,Sequencing andexecution,Microoperations,Examples ofmicroprograms.	
5		**MemoryOrganization**	**5**
	5.1	Introductionandcharacteristics ofmemory	
	5.2	CacheMemory: Concept,localityofreference, Designproblemsbasedon mappingtechniques, Cachecoherenceandwritepolicies. InterleavedandAssociativeMemory.	
6		**PrinciplesofAdvancedProcessorandBuses**	**6**
	6.1	BasicPipelinedDatapathandcontrol,datadependencies,datahazards, branchhazards,delayedbranch,andbranchprediction,Performance measures-CPI,Speedup,Efficiency,throughput,Amdhal‟slaw.	
	6.2	Flynn‟sClassification,Introductiontomulticorearchitecture.	
	6.3	Introductiontobuses: ISA,PCI,USB.BusContentionandArbitration.	

Textbooks:	
1	R.P.Jain,"ModernDigitalElectronic",McGraw-HillPublication, 4 Edition.
2	WilliamStalling,"ComputerOrganizationandArchitecture:DesigningandPerformance",Pearsonpublication 10TH Edition.
3	JohnPHayes,"ComputerArchitectureand Organization",McGraw-HillPublication, 3 Edition.
4	Dr.M.UshaandT.S.Shrikanth,"Computersystem ArchitectureandOrganization", Wileypublication.
References:	
1	AndrewS.Tanenbaum,"StructuredComputerOrganization",PearsonPublication.
2	B.Govindarajalu,"ComputerArchitectureandOrganization",McGraw-HillPublication.
3	Malvino,"DigitalcomputerElectronics",McGraw-HillPublication, 3 Edition.
4	SmrutiRanjanSarangi,"ComputerOrganizationandArchitecture",McGraw-HillPublication.

Assessment:	
InternalAssessment:	
Assessment consists of two class tests of 20 marks each. The first class test is to be conductedwhen approx. 40% syllabus is completed and second class test whenadditional 40% syllabusiscompleted. Duration ofeach test shall beonehour.	
EndSemesterTheoryExamination:	
1	Questionpaperwill compriseof6questions,eachcarrying20marks.
2	Thestudents needto solve total4 questions.
3	QuestionNo.1willbecompulsoryandbasedonentiresyllabus.
4	Remainingquestion(Q.2toQ.6)will beselectedfromall themodules.

UsefulLinks	
1	https://www.classcentral.com/course/swayam-computer-organization-and-architecture-a-pedagogical-aspect-9824
2	https://nptel.ac.in/courses/106/103/106103068/
3	https://www.coursera.org/learn/comparch
4	https://www.edx.org/learn/computer-architecture

CourseCode	CourseName	Credits
CSC305	ComputerGraphics	3

Prerequisite: KnowledgeofCProgrammingandBasicMathematics**.**	
CourseObjectives	
1	Toequipstudentswiththefundamentalknowledgeandbasic technicalcompetenceinthe fieldofComputerGraphics.
2	Toemphasizeonimplementation aspectofComputerGraphicsAlgorithms.
3	Topreparethestudentforadvanceareasandprofessional avenuesinthefield ofComputerGraphics
CourseOutcomes: Attheend ofthe course, thestudents should beableto	
1	Describethebasicconceptsof ComputerGraphics.
2	Demonstratevariousalgorithmsforbasicgraphics primitives.
3	Apply2-D geometrictransformations ongraphical objects.
4	UsevariousClippingalgorithms ongraphicalobjects
5	Explore3-Dgeometrictransformations,curverepresentationtechniquesandprojectionsmethods.
6	ExplainvisiblesurfacedetectiontechniquesandAnimation.

Module		DetailedContent	Hours
1		**IntroductionandOverviewofGraphicsSystem:**	**01**
	1.1	DefinitionandRepresentativeusesofcomputergraphics.	
2		**OutputPrimitives:**	**05**
	2.1	Scanconversionsofpoint,line,midpointalgorithmforellipse drawing(Mathematicalderivation forabovealgorithmsisexpected)	
	2.2	Aliasing,AntialiasingtechniqueslikePreandpostfiltering,super sampling,andpixelphasing).	
	2.3		
3		**TwoDimensionalGeometricTransformations**	**3**
	3.1	Basictransformations:Translation,Scaling,Rotation	
	3.2	Matrix representationandHomogeneousCoordinates	
4		**Two-DimensionalViewingandClipping**	**3**
	4.1	ViewingtransformationpipelineandWindowtoViewport coordinatetransformation	
	4.2	Clippingoperations:Pointclipping, Line	
5		**ThreeDimensionalGeometricTransformations,Curvesand FractalGeneration**	**3**
	5.1	3DTransformations:Translation,Rotation,ScalingandReflection	
6		**VisibleSurfaceDetectionandAnimation**	**5**
	6.1	VisibleSurfaceDetection:ClassificationofVisibleSurface Detectionalgorithm,BackSurfacedetectionmethod, DepthBuffer method,AreaSubdivision method	
	6.2	Animation: Introduction toAnimation,TraditionalAnimation Techniques,PrinciplesofAnimation, Keyframing: Characterand FacialAnimation,Deformation, Motioncapture	

Textbooks:	
1	Hearn&Baker,"ComputerGraphicsCversion",2ndEdition,PearsonPublication
2	JamesD.Foley, AndriesvanDam,Steven KFeiner,John F.Hughes,"ComputerGraphics PrinciplesandPracticeinC",2nd Edition, Pearson Publication
3	SamitBhattacharya,"ComputerGraphics",OxfordPublication

References:	
1	D. Rogers, "Procedural Elements for Computer Graphics", Tata McGraw-HillPublications.
2	Zhigang Xiang, Roy Plastock, "Computer Graphics", Schaum"s Outlines McGraw-HillEducation
3	RajeshK.Maurya,"ComputerGraphics",WileyIndiaPublication.
4	F.S.Hill,"ComputerGraphicsusingOpenGL",Thirdedition,PearsonPublications.

Assessment:	
InternalAssessment:	
Assessment consists of two class tests of 20 marks each. The first class test is to be conductedwhenapprox.40%syllabus iscompletedandsecondclasstestwhenadditional40%syllabusiscompleted.Duration ofeach test shall beonehour.	
EndSemesterTheoryExamination:	
1	Questionpaperwill compriseof6questions,eachcarrying20marks.
2	Thestudents needto solve total4 questions.
3	QuestionNo.1willbecompulsoryandbasedonentiresyllabus.
4	Remainingquestion(Q.2toQ.6)will beselectedfromall themodules

UsefulLinks	
1	https://www.classcentral.com/course/interactivegraphics-2067
2	https://swayam.gov.in/nd2_ntr20_ed15/preview
3	https://nptel.ac.in/courses/106/106/106106090/
4	https://www.edx.org/course/computer-graphics-2

Lab Code	LabName	Credit
CSL301	DataStructuresLab	1

Prerequisite:CProgrammingLanguage.	
LabObjectives:	
1	Toimplementbasicdatastructuressuchasarrays,linkedlists,stacksandqueues
2	Solveprobleminvolvinggraphs,andtrees
3	Todevelopapplicationusingdatastructurealgorithms
4	Computethe complexityofvarious algorithms.
LabOutcomes:	
1	Studentswillbeabletoimplement lineardatastructures&beabletohandleoperationslikeinsertion, deletion, searchingand traversingon them.
2	Studentswillbeable toimplementnonlineardatastructures&beabletohandleoperationslikeinsertion, deletion, searchingand traversingon them
3	Studentswill beable tochooseappropriatedatastructure andapplyit invarious problems
4	Studentswill beabletoselectappropriatesearchingtechniquesforgivenproblems.

SuggestedExperiments: Studentsarerequiredtocompleteatleast6-7experiments.

Sr.No.	Nameof theExperiment
1	ImplementStackADTusingarray.
2	ConvertanInfixexpressiontoPostfixexpressionusingstackADT.
3	EvaluatePostfixExpressionusingStackADT.
4	ApplicationsofStackADT.
5	ImplementPriorityQueueADTusingarray.
6	ImplementDoublyLinked ListADT.
7	ImplementStack/ LinearQueueADTusingLinked List.
8	ImplementGraphTraversaltechniques:)DepthFirstSearchb)BreadthFirstSearch
9	ApplicationsofBinarySearchTechnique.
UsefulLinks:	
1	www.leetcode.com
2	www.hackerrank.com
3	www.cs.usfca.edu/~galles/visualization/Algorithms.html
4	www.codechef.com

TermWork:	
1	Termworkshouldconsist of6-7experiments.
2	Journalmustincludeatleast1assignment.
3	Thefinalcertificationandacceptanceoftermworkensuresthatsatisfactoryperformanceoflaboratorywork and minimum passingmarks interm work.
4	Total25Marks(Experiments:15-marks,AttendanceTheory&Practical:05-marks,Assignments:05-marks)
Oral&Practicalexam	
	Basedontheentiresyllabus ofCSL301andCSC303

LabCode	LabName	Credit
CSL302	DigitalLogic&ComputerOrganizationandArchitectureLab	1

Prerequisite:CProgrammingLanguage.	
LabObjectives:	
1	Toimplementoperations ofthearithmeticunitusingalgorithms.
2	Design andsimulatedifferentdigitalcircuits.
3	Todesignmemorysubsystem includingcachememory.
4	TodemonstrateCPUand ALUdesign.
LabOutcomes:	
1	Tounderstandthebasicsofdigitalcomponents
2	Designthebasicbuilding blocksofacomputer:ALU, registers,CPUandmemory
3	Torecognizetheimportanceofdigitalsystems incomputerarchitecture
4	Toimplementvariousalgorithms forarithmeticoperations.

SuggestedExperiments: Studentsarerequiredtocompleteatleast6-7experiments.	
Sr.No.	**NameoftheExperiment**
1	Toverifythetruthtableofvariouslogic gatesusingICs.
2	ToimplementBooth"salgorithm.
3	Toimplementrestoringdivision algorithm.
4	Toimplementnonrestoringdivision algorithm.
5	ToimplementALUdesign.
6	Toimplement CPUdesign.
7	Toimplementmemorydesign.
8	Toimplementcachememorydesign.

Note:	
1	AnyFour experimentsfromExp.No. 1to Exp.No.7 usinghardware.
2	AnySixexperimentsfrom Exp. No.8toExp. No.16 usingVirtualLab,expect Exp.No10,11and12.
3	Exp.No. 10to Exp.No.12 usingProgramminglanguage.
DigitalMaterial:	
1	ManualtouseVirtualLabsimulatorforComputerOrganizationandArchitecturedeveloped bytheDepartment of CSE,IITKharagpur.
2	Linkhttp://cse10-iitkgp.virtual-labs.ac.in/

TermWork:	
1	Termworkshouldconsist of6-7experiments.
2	Journalmustincludeatleast1assignmentson contentoftheoryandpractical of"DigitalLogic &Computer Organization and Architecture"
3	Thefinalcertificationandacceptanceoftermworkensuresthatsatisfactoryperformanceoflaboratorywork and minimum passingmarks in termwork.
4	Total25Marks(Experiments:15-marks,AttendanceTheory&Practical:05-marks, Assignments:05-marks)

CourseCode	LabName	Credits
CSL303	ComputerGraphicsLab	1

Prerequisite:CProgrammingLanguage.	
LabObjectives:	
1	Understandtheneedofdevelopinggraphicsapplication
2	Learnalgorithmicdevelopmentofgraphicsprimitiveslike:line,circle,polygonetc.
3	Learntherepresentation and transformationofgraphicalimagesandpictures
Lab Outcomes: Attheendofthecourse,thestudentsshouldbeableto	
1	Implementvariousoutputandfilledareaprimitivealgorithms
2	Applytransformation, projectionandclippingalgorithmsongraphicalobjects.
3	Performcurveandfractalgenerationmethods.
4	DevelopaGraphicalapplication/Animationbasedonlearnedconcept

SuggestedExperiments: Studentsarerequiredtocompleteatleast6-7experiments.

Sr.No.	NameoftheExperiment
1	ImplementLineDrawingalgorithm
2	ImplementmidpointEllipsealgorithm.
3	ImplementAreaFillingAlgorithm:
4	ImplementScanlinePolygon Fillingalgorithm.
5	ImplementCurve: Bezierforncontrolpoints,BSpline(Uniform)(at leastone)
6	Implement2DTransformations:.
7	Programtoperform3Dtransformation.
8	Programtoperformprojectionofa3DobjectonProjectionPlane:ParallelandPerspective.
9	ProgramtoperformAnimation(suchasRisingSun,MovingVehicle,Smileys,Screensaver etc.)

TermWork:	
1	Termworkshouldconsist of6-7experiments.
2	Journalmustincludeatleast1assignments
3	MiniProjecttoperformusingC/C++/Java/OpenGL/Blender/ anyothertool (2/3students pergroup).Possible Ideas:Animationusingmultipleobjects,Gamedevelopment,Graphicseditor:LikePaint brush, Text editor etc.
4	Thefinalcertificationandacceptanceoftermworkensuresthatsatisfactoryperformanceoflaboratorywork and minimum passingmarks in termwork.
5	Total25Marks(Experiments:10-marks,AttendanceTheory&Practical:05-marks, Assignments:05-marks, MiniProject:5-marks)
Oral&Practicalexam	
Basedontheabovecontents andentiresyllabusof CSC305ComputerGraphics	

Lab Code	LabName	Credits
CSL304	SkillbasedLabCourse:ObjectOrientedProgrammingwithJava	2

Prerequisite: StructuredProgrammingApproach	
LabObjectives:	
1	Tolearnthebasicconceptsofobject-orientedprogramming
2	TostudyJAVAprogramminglanguage
3	Tostudyvariousconcepts ofJAVAprogramming likemultithreading, exceptionHandling,packages,etc.
4	ToexplaincomponentsofGUIbasedprogramming.
Lab Outcomes: Attheendofthecourse,thestudentsshouldbeableto	
1	Toapplyfundamental programmingconstructs.
2	Toillustratetheconceptofpackages,classesand objects.
3	Toelaboratetheconceptofstrings,arraysandvectors.
4	Toimplementtheconcept ofinheritanceandinterfaces.
5	Toimplementtheconcept ofexceptionhandlingandmultithreading.
6	TodevelopGUIbasedapplication.

Module		DetailedContent	Hours
1		**IntroductiontoObjectOrientedProgramming**	**1**
	1.1	OOPconcepts:Objects,class,Encapsulation,Abstraction, Inheritance,Polymorphism,messagepassing.	
2		**Class,Object,PackagesandInput/output**	**1**
	2.1	OverviewofClass,object,datamembers,memberfunctions OverviewMethodoverloading	
3		**Array,String andVector**	**2**
	3.1	Array,Strings,Vectors	
4		**Inheritance**	**2**
	4.1	Typesofinheritance,Methodoverriding,	
5		**ExceptionhandlingandMultithreading**	**3**
	5.1	OverviewofExceptionhandlingmethods	
6		**GUIprogramminginJAVA**	**3**
	6.1	Appletandappletlifecycle,creatingapplets, AWT:workingwithwindows, usingAWT controlsforGUIdesign Swingclass in JAVA IntroductiontoJDBC,	

Textbooks:	
1	HerbertSchildt,„JAVA:TheCompleteReference“,NinthEdition,OraclePress.
2	E.Balagurusamy,„ProgrammingwithJava“,McGrawHillEducation.
References:	
1	IvorHorton,“BeginningJAVA“,WileyIndia.
2	DietalandDietal,“Java:HowtoProgram“,8thEdition,PHI.
3	“JAVAProgramming“, BlackBook,DreamtechPress.
4	“LearntoMasterJavaprogramming“,Staredusolutions

Digitalmaterial:	
1	www.nptelvideos.in
2	www.w3schools.com
3	www.tutorialspoint.com
4	https://starcertification.org/Certifications/Certificate/securejava

SuggestedExperiments: Studentsarerequiredtocompleteatleast6-7experiments.	
Sr.No.	**NameoftheExperiment**
1	Programsonclassandobjects
2	ProgramonPackages
3	Programon2Darray,stringsfunctions
4	ProgramonStringBufferandVectors
5	ProgramonMultipleInheritance
6	Programonabstractclass andabstract methods.
7	Programusingsuperandfinalkeyword
8	ProgramonExceptionhandling
9	ProgramonGraphicsclass
10	Programonappletclass
11	ProgramtocreateGUIapplication
*MiniProjectbasedonthecontentofthesyllabus(Groupof2-3 students)	

TermWork:	
1	Termworkshouldconsist of6-7experiments.
2	Journalmustincludeatleast1assignments
3	MiniProjectbasedonthecontentofthesyllabus(Group of2-3students)
4	Thefinalcertificationandacceptanceoftermworkensuresthatsatisfactoryperformanceoflaboratorywork and minimum passingmarks in termwork.
5	Total50-Marks(Experiments:15-marks,Attendance:05-marks,Assignments:05-marks, MiniProject:20-marks,MCQasapartoflabassignments:5-marks)

Oral&Practicalexam
BasedontheentiresyllabusofCSL304:**SkillbasedLab Course:ObjectOrientedProgrammingwith Java**

Coursecode	CourseName	Credits
CSM301	MiniProjectA	02

Objectives	
1	Toacquaint withtheprocessofidentifyingtheneedsandconvertingitintotheproblem.
2	Tofamiliarizetheprocess ofsolvingtheproblem inagroup.
3	Toacquaintwiththeprocessofapplyingbasicengineeringfundamentalstoattemptsolutionsto theproblems.
4	Toinculcatetheprocessofself-learningandresearch.
Outcome: Learnerwill beableto…	
1	Identifyproblemsbasedonsocietal/researchneeds.
2	ApplyKnowledgeandskill tosolvesocietalproblems inagroup.
3	Developinterpersonal skills toworkasmemberofagrouporleader.
4	Draw the proper inferences from available results through theoretical/experimental/simulations.
5	Analyze theimpactofsolutionsinsocietalandenvironmentalcontextforsustainabledevelopment.
6	Usestandardnormsofengineeringpractices
7	Excelinwrittenandoral communication.
8	Demonstratecapabilitiesofself-learninginagroup,whichleadstolifelong learning.
9	Demonstrateproject managementprinciplesduringprojectwork.
GuidelinesforMiniProject	
1	Studentsshallformagroupof3to4students,whileformingagroupshallnotbeallowedlessthanthree ormorethan fourstudents, as itis agroup activity.
2	Studentsshoulddosurveyandidentifyneeds, whichshallbeconvertedintoproblemstatement for mini project in consultation with faculty supervisor/head of department/internalcommitteeoffaculties.
3	Studentsshallsubmitimplementationplanintheformof Gantt/PERT/CPMchart,whichwill coverweeklyactivityofmini project.
4	Alogbooktobepreparedbyeachgroup,whereingroupcanrecordweeklyworkprogress,guide/super visorcan verifyand record notes/comments.
5	Facultysupervisormaygiveinputstostudentsduringminiprojectactivity;however,focusshallbeo n self-learning.
6	Studentsinagroupshallunderstandproblemeffectively,proposemultiplesolutionandselectbest possiblesolution inconsultationwith guide/ supervisor.
7	Studentsshallconvertthebestsolutionintoworkingmodelusingvariouscomponentsoftheirdomai n areasanddemonstrate.
8	Thesolutiontobevalidatedwithproperjustificationandreporttobecompiledinstandardformatof UniversityofMumbai.
9	Withthefocusontheself-learning,innovation,addressingsocietalproblemsandentrepreneurship quality development within the students through the Mini Projects, it ispreferablethatasingleprojectofappropriatelevelandqualitytobecarriedoutintwo semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV.Similarly,MiniProject2 in semestersVandVI.
10	However,basedontheindividualstudentsorgroupcapability,withthementor‟srecommendations ,iftheproposedMiniProjectadheringtothequalitativeaspectsmentionedabovegetscompletedino ddsemester,thenthatgroupcanbeallowedtoworkontheextensionoftheMiniProjectwithsuitablei mprovements/modificationsora completely new project idea in even semester. This policy can be adopted on case by casebasis.

TermWork

Thereview/progressmonitoringcommitteeshallbeconstitutedbyheadofdepartmentsofeachinstitute.Theprogressofminiprojecttobeevaluatedon continuousbasis,minimumtwo reviewsineachsemester.

Incontinuousassessmentfocusshallalsobeoneachindividualstudent,assessmentbasedonindividual‟s contributioningroupactivity,theirunderstandingandresponsetoquestions.

	DistributionofTermworkmarksforbothsemestersshallbeasbelow:	**Marks**
1	Marksawardedbyguide/supervisor basedonlogbook	10
2	Marksawardedbyreviewcommittee	10
3	QualityofProjectreport	05

Review / progress monitoring committee may consider following points forassessment based on either one year or half year project asmentioned ingeneral guidelines

One-yearproject:

1	In first semester entire theoretical solution shall be ready, including components/systemselection and cost analysis. Two reviews will be conducted based on presentation given bystudentsgroup. • Firstshallbeforfinalisationofproblem • Secondshallbeonfinalisationofproposedsolutionofproblem.
2	In second semester expected work shall be procurement of component‟s/systems, buildingof working prototype, testing and validation of results based on work completed in anearliersemester. • Firstreviewis basedon readinessofbuildingworkingprototypeto be conducted. • Second review shall be based on poster presentation cum demonstration of workingmodelin last month of the said semester.

Half-yearproject:

1	Inthiscaseinonesemesterstudents‟groupshallcompleteprojectinallaspectsincluding, • Identificationofneed/problem • Proposedfinal solution • Procurementofcomponents/systems • Buildingprototype and testing
2	Tworeviews willbeconductedforcontinuous assessment, • Firstshallbeforfinalization ofproblemand proposedsolution • Secondshall beforimplementation and testingofsolution.

AssessmentcriteriaofMiniProject.

MiniProjectshall beassessed basedon followingcriteria;

1	Qualityofsurvey/ needidentification
2	Clarityof Problem definition basedon need.
3	Innovativenessinsolutions
4	Feasibilityofproposedproblemsolutions andselectionofbestsolution
5	Costeffectiveness
6	Societalimpact
7	Innovativeness

8	Cost effectiveness and Societal impact
9	Full functioning of working model as per stated requirements
10	Effective use of skill sets
11	Effective use of standard engineering norms
12	Contribution of an individual"s as member or leader
13	Clarity in written and oral communication
	In **one year, project**, first semester evaluation may be based on first six criteria"s and remaining may be used for second semester evaluation of performance of students in mini project.
	In case of **half year project** all criteria"s in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

1	Report should be prepared as per the guidelines issued by the University of Mumbai.
2	Mini Project shall be accessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations having experience of more than five years approved by head of Institution.
3	Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on following points;

1	Quality of problem and Clarity
2	Innovativeness in solutions
3	Cost effectiveness and Societal impact
4	Full functioning of working model as per stated requirements
5	Effective use of skill sets
6	Effective use of standard engineering norms
7	Contribution of an individual"s as member or leader
8	Clarity in written and oral communication

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