Central Institute of Technology, Kokrajhar

BTAD, Assam

Approved by MHRD and AICTE

SYLLABUS OF

ANIMATION AND MULTIMEDIA TECHNOLOGY

Module: Diploma **Batch: A & MT** **Year: 2nd Year** **Semester: 1stSem**

Course Code	Name of Course	L-T-P	Credit
Co-301	Computer Application	2-0-6	05
Hu-302	Engineering Economics & Accountancy	3-1-0	04
Sc-303	Mathematics-III	3-2-0	05
IT-301	Information Technology	3-1-0	04
AMT-301	Multimedia Systems & Technology	4-0-2	05
AMT-302	Introduction to Animation	3-1-0	04

Module: Diploma **Batch: A & MT** **Year: 2nd Year** **Semester: 2ndSem**

Course Code	Name of Course	L-T-P	Credit
AMT-401	2D & Flash Animation	2-0-6	05
AMT-402	Web Designing	2-0-6	05
AMT-403	3D Modeling	2-0-6	05
AMT-404	Texturing	2-0-6	05
AMT-405	Rigging	2-0-6	05

Module: Diploma **Batch: A & MT** **Year: 3rd Year** **Semester: 1stSem**

Course Code	Name of Course	L-T-P	Credit
AMT-501	3D- Animation	2-0-6	05
AMT-502	CG Lighting	2-0-6	05
AMT-503	Compositing	2-0-6	05
AMT-504	Visual Effects	2-0-6	05
AMT-505	Audio & Video Editing	2-0-6	05
AMT-599	Minor Project	0-0-6	03

Module: Diploma **Batch: A & MT** **Year: 3rd Year** **Semester: 2ndSem**

Course Code	Name of Course	L-T-P	Credit
Hu-601	Industrial Management and Entrepreneurship	3-1-0	04
CAI-605	Computer Programming with C/C++	3-0-4	05
AMT-60*	Specialization-I	2-0-8	06
	1. 3D Modeling (AMT-601) 2. Rigging (AMT-603) 3. CG Lighting (AMT-605) 4. Visual Effects (AMT-606)		
AMT-60*	Specialization-II	2-0-8	06
	1. Texturing (AMT-602) 2. 3D Animation (AMT-604) 3. Compositing (AMT-607)		
AMT-699	Major Project	0-0-20	10

Course Name: Computer Application   **L – T – P: Cr**

Course Code: Co-301   **2 – 0 – 6: 05**

Full Marks: 100   **Theory:** 28/70   **Sessional:** 15/30

Unit I: Computer Fundamentals
Brief history – Babbage machine, Von Neumann. Architecture – Block diagrams, Role of Operating Systems, concept of language and language translators, editors. Memory – different types, functions, concept of I/O devices.

Unit II: Number System
Number system and codes: Decimal, binary, octal, hexadecimal number systems and conversion from one system to another, arithmetic operations using these numbers. Representation of a negative number in the different number systems. Complement and complement subtraction. Different codes: ASCII, 8421, Ex-3, 2421, gray, Alpha-numeric, BCD, Seven segment codes etc. and code conversion.

Unit III: Introduction to Operating System
Concept of resource management, single user and multi user OS, Various popular OS (DOS, Windows, Unix/ Linux), elementary commands.

Unit IV: Introduction to Internet
Fundamentals of networking – need of network topology, concept of LAN, WAN, MAN, network devices – NIC, hub, bridge, switch, repeaters, gateway, modem, transmission media. Internet services, concept of global net, different browsers, search engine.

Unit V: MS – Office:
Various products, their introduction and uses.

Course Name: Computer Application Practical

Course Code: Co-301(P)

Full Marks: 50   **Practical:** 25   **Sessional:** 25

1. **Introduction to MS Office**: Basic feature of MS Office, Overview of different Office Tools.
2. **Introduction to MS Word**: Creating and editing document, formatting documents, working with Tables, Spell checking, Mail Merging, Importing Graphics into word Document.
3. **Introduction to MS Excel**: Creating a new work book, entering labels, values and formulas, formatting the layout, working with functions, creating chart from data writing macros.
4. **Introduction to Power Point**: Creating a presentation, adding/ editing text, working with objects, formatting the presentation, placing the chart in slide, slide show and printing.
5. **Introduction to MS Access**: Creation of database. Creation of tables – field declaration, data type declaration, constraint declaration, working with records, querying the data base, joining tables, designing the form, the report.

Reference Books:

1. DOS quick reference: Rajib Mathur
2. Learning Word for Windows : Rajib Mathur
3. Learning Windows step by step: Rajib Mathur
4. Microsoft office unleashed: Techmedia
5. ABC of Office: Han
6. Mastering Excel: Chester
7. Excel 97 Bible: John Walkenbach
8. Teach yourself MS Access in 24 hours: Eddy and Buchanan
9. Microsoft Access 2000 fast and easy: Primatech BBP
10. Unix: S. Das

ENGINEERING ECONOMICS & ACCOUNTANCY

Code: Hu-302	Theory: 70	L – T – P:
Total Marks: 100	Sessional: 30	3 – 0 – 0

PART A: ENGINEERING ECONOMICS

1. Introduction to Economics and its utility and scope of study.
2. Meaning and definition of utility, consumption, want value, price of goods, national income.
3. Meaning of wealth and its characteristics, classification of wealth.
4. Basic laws of demand and supply and its limitations.
5. Meaning and factors of production, land labour, capital and organisation, factors determining efficiency of labour.
6. Scale of Industries: types, advantages and disadvantages of large and small scale industries.
7. Unemployment: causes of unemployment in India and its remedies.

PART B: ACCOUNTANCY

8. Definitions, objects and principles of double entry book-keeping.
9. Transactions, classification of accounts, rules of credit and debit.
10. Journal and Ledger: Definition, posting and balance of accounts.
11. Cash Book: Single column, double column, triple column cashbook, impress system of petty cash book.
12. Trial Balance: Object of Trial balance preparation, types of errors.
13. Final accounts: preparation of trading account, profit and loss account and balance sheet.

MATHEMATICS – III

Code: Sc-303	Theory: 70	L – T – P:
Total Marks: 100	Sessional: 30	3 – 2 – 0

GROUP A: DIFFERENTIAL EQUATIONS

1.0 Differential Equations: Definition and classification, order and degree, importance of differential equations in Engineering Field.
  1.1 Formation of ordinary differential equations.
2.0 Equation of the first order and of first degree with reference to Engineering.
  2.1 Separation of variables, equations reducible to variable separable form.
  2.2 Homogenous equations and its special form.
  2.3 Exact equation.
  2.4 Integrating factors – definition and rules of determining integrating factors.
  2.5 Linear equations and its solution.
  2.6 Bernoulli's equation.
3.0 Equations of first order but not of the first degree.
  3.1 Left hand side resolvable into factors
  3.2 Left hand side not resolvable into factors
  3.3 Clairaut's equation.
  3.4 Practice on units 3.1, 3.2, 3.3
4.0 DIFFERENTIAL EQUATIONS OF SECOND ORDER WITH CONSTANT CO-EFFICIENTS
  4.1 Linear equations with right hand number zero: introduction to operator D. Auxiliary equation having real and distinct roots, having equal roots, having a pair of complex roots.
  4.2 Equations with right hand member as an algebraic expression, trigonometric and exponential functions of X. Solution of linear equations: general and particular integral, complementary functions.
  4.3 Engineering application of differential equations such as L-R circuit, L-R-C circuit, Simple Harmonic Motion, Rate of growth and decay etc.

GROUP B: GRAPHICS

1.0 INTRODUCTION AND ITS CONCEPT
  1.01 Graphical solution of equations.
  1.02 Cubic equation (one part cubic and the other part linear)
  1.03 Quadratic equations
  1.04 Trigonometric equations
2.0 DETERMINATION OF LAWS OF FITTING OF CURVES
  Linear, Quadratic, Exponential, Binomial etc.

GROUP C: STATISTICS

1.0 INTRODUCTION AND ITS APPLICATIONS IN ENGINEERING FIELD
2.0 MEASURES OF CENTRAL TENDENCY
      2.01   Mean, median and mode (with illustration)
      2.02   Relation between them, the empirical formula.

3.0 MEASURES OF DISPERSION

      3.01   Range, Mean Deviation and Standard deviation (with illustration)
      3.02   Variation and coefficient of variation
4.0 CORRELATION

      4.01   Meaning of correlation as a bi-variate relation, scatter diagram.
      4.02   Karl Pearson's correlation formula for two variables
      4.03   Determination of correlation by Karl Pearson's formula with reference to engineering applications.
5.0 PROBALITY
      5.01   Introduction to Probability
      5.02   Events: mutually exclusive events, exhaustive events etc.
      5.03   Definition of probability
      5.04   Addition and Multiplication laws of probability
      5.05   Examples on probability.

GROUP D: ANALYTICAL GEOMETRY OF 3-DIMENSIONS AND INTRODUCTION TO VECTOR ANALYSIS
1.0   INTRODUCTION AND DEFINITIONS
      1.1   Three dimensional rectangular Cartesian co-ordinates, co-ordinates of a point in space with reference to vectors, addition and subtraction formula.
      1.2   Coordinates of a point which divides a straight line in a given ratio.
      1.3   Distance between two points.
2.0   DIRECTION RATIOS AND DIRECTION COSINES WITH REFERENCE TO VECTORS
      2.1   Definition of direction ratios and direction cosines
      2.2   Properties of direction ratios and direction cosines
      2.3   Relation between direction ratios and direction cosines
      2.4   Angle between two lines in vector form
      2.5   Condition of perpendicularity and parallelism.

Recommended books:
1. Integral calculus: Das & Mukherjee
2. Engineering Mathematics: Shanti Narayan
3. An Introduction to Statistics (Vol. I&II): L. Choudhury
4. An easy approach to statistics: S.P. Gupta

5. Analytical Solid Geometry: Misra & Misra
6. Higher Secondary Mathematics: B.S. Grewal
7. Vector & Mechanics: Mena & Mishra

Course Name: Information Technology   **L – T – P: Cr**

Course Code: IT-301   **3 – 1 – 0: 05**

Full Marks: 100   **Theory:** 28/70   **Sessional:** 15/30

Unit I:

Information Concept and Processing:

Definition of information, Data vs information, Introduction to Information representation in

Digital Media, Text, image, graphics, Animation, Audio, Video etc.

Unit II

Information Representation:

Information content, Entropy, Data Compression, Introduction to various compression techniques, Shannon Fano, Huffman Coding, LZW coding, Introduction to JPEG, MPEG, MHEG and other IT Industry Standards.

Unit III:

Concept in Computer & Programming: Computer Application:

Definition of Electronic Computer, History, Generations, Characteristic and Application of Computers, Classification of Computers, RAM/ROM.

Unit IV:

Programming Language Classification & Program Methodology:

Computer Languages, Generation of Languages, Translators- Interpreters, Compiler/ Interpreters,

Compliers, Assemblers, Flow charts.

Unit V:

Digital Devices and Basic Network Concepts. Digital Fundamentals:

Various Codes, decimal, binary, octal, hexadecimal conversion.

Unit VI:

Data Communication & Networks:

Computer Networks, Networking of Computers- Introduction of LAN and WAN, Network Topologies.

Unit VII:

Internet and Web Technologies. Internet and World Wide Web:

Hypertext Markup Language, DHTML,WWW, Gopher, FTP, Telnet, Web Browsers, Net Surfing, Search Engines, Email, ISP, EDI, E-Commerce.

Unit VIII:

Concepts in Operating System, Office Tools and Data Management

Introductory concepts in operating system & Data Management: Elementary concepts in Operating System, textual vs GUI Interface, Introduction to DOS, MS Windows, MS office tools, MS Word, MS Excel, MS Power Point, Tool for Data Management, Basics of Database management system, Introduction to basic Commands of Dbase, FoxPro, SQL etc.

IT Industry Trends, Careers and Applications in India: Scientific, Business, Educational and Entertainment Application, Industry Automation, Weather forecasting, Awareness of ongoing IT projects in India NICNET, BRNET, etc. Application of IT to other Areas E-Commerce, electronic governance, Multimedia, Entertainment.

Reference Books:

- D. S. Yadav, "Foundation of IT", New Age, Delhi.
- Curtin, "Information Technology: Breaking News", TMH.
- Rajaraman, "Introduction to Computers", PHI.
- Nelson, "Data Compression", BPB.
- Leon & leon "Fundamental of Information Technology", Vikas

Course Name: Multimedia Systems and Technology   **L - T – P: Cr**

Course Code: AMT-301   **4 – 0 – 2: 05**

Total Marks: 100   **Theory:** 28/70   **Sessional:** 15/30

Unit-I:

Introduction to Multimedia, Multimedia definition, Multimedia Application, Multimedia System, Multimedia Information, Multimedia Objects, Multimedia in business and work, Characteristics of Multimedia, Components of Multimedia System, Multimedia Data: Input and format.

Unit-II:

Multimedia data basics, Static and Continuous media, Analog and Digital Signals, Text and Static data, Analog to Digital and Digital to Analog Conversion, Text, Graphics, Images, Audio, Video.

Unit-III:

Multimedia data representation, Digital Audio, image formats, audio file formats, video formats, Multimedia hardware, Memory and storage devices, Communication devices. Compression, Compression ratio, Lossless & Lossy compression.

Unit-IV:

Overview of Internet, Browsers, Internet services- URL, Dial-ups, ISDN, e-mail, chat, cross-platform features, audio & video streaming, Internet applications – Audio & video conferencing, Internet telephony, World Wide Web, Computer networks, Virtual reality.

Unit-V:

Multimedia presentation and authoring, professional development tools, the Stages of a Multimedia Project, Requirements of a Multimedia Project, Building up a Team, Duties of a Project Manager, Multimedia Designer, Interface Designer, Content Writer, Video and Audio Specialist, Multimedia Programmer, Implementing Multimedia with the World Wide Web.

Reference Books:

\#   "Multimedia, Making IT Work" – by Tay Vaughan; Osborne McGraw Hill.

\#   "Multimedia Systems" – by Buford; Addison Wesley

\#   "Multimedia Systems" – by Agrawal & Tiwari; Excel

Course Name: Introduction to Animation   **L- T – P: Cr**

Course Code: AMT-302   **3 – 1 – 0: 04**

Total Marks: 100   **Theory:** 28/70   **Sessional:** 15/30

UNIT I:

Different Types of Animation, Introduction to Pre-Production, Scripting, Storyboarding, Layout, Character Designing, Props Designing, Background Designing, Camera Angles, Frame Lengths, Introduction to 2D Animation.

UNIT II:

Introduction to Production, Introduction to 3D animation, Modeling, Texturing, Rigging, Animation.

UNIT III:

Lighting, Dynamics, VFX, Introduction to Post-Production, Compositing, Rendering, Tools of the trade.

UNIT IV:

The World of Gaming, Different types of games, Scope of Animation, Various positions in the Animation Industry.

Reference Books

"Beginner's Guide to Animation" – by Mark Murphy; Watson-Guptill Publication

"Producing Animation" – by Catherine Winder & Zahra Dowlatabadi; Focal Press

"Drawn to Life: 20 Golden Years of Disney Master Classes: Volume 1" – by Walt Stanchfield;

Focal Press

Course Name: 2D and Flash Animation   **L – T – P: Cr**

Course Code: AMT-401   **2 – 0 – 6: 05**

Full Marks: 100   **Theory:** 28/70   **Sessional:** 15/30

UNIT I:

Line of Action, Gesture Drawing, Composition, The Pipe and Box Model, The Rules of Perspective, Understanding Anatomy, Caricatured Head Shapes.

UNIT II:

Scripting, Storyboarding, Character Designing, Prop Designing, Background Designing, Concepts of sketching, Cartoon Drawing, Life-like Drawing.

UNIT III:

2D Animation, Layout and Background Painting – Basic and Advanced Techniques Layout and Basic and Advanced Techniques in BG Painting. (*The student will learn everything from introductory concepts of perspective, colour keys to advanced techniques in layout and background painting. The class is geared up towards the beginner to intermediate student, and is centered on layout for animation.*)

UNIT IV:

Cleanup and In-between – Introductory concepts to basic techniques in Animation, Principles of Animation, Production of cleanups and in-betweens. (*The class is geared up towards the beginner to intermediate student and is centered on Cleanups and in-betweens for 2D Character Animation.*)

UNIT V:

Cell Animation, Using Adobe Flash, Graphics Tools, Working with Symbols, Layers, Creating Animation, Adding Video and Audio, Publishing movies, Using ActionScripts, Integrating Flash with other Multimedia Products.

Reference books:

Cartoon Animation -- by Preston Blair

The Art of Flash Animation: Creative Cartooning -- by Mark Stephen Smith

Building Flash Websites for Dummies -- by Doug Sahlin

The Art of Animal Drawing -- by Ken Hultgren

Perspective Drawing Handbook -- by Joseph D'Amelio

Flash CS5: The Missing Manual -- by Chris Grover

Course Name: Web Designing   **L – T - P: Cr**

Course Code: AMT-402   **2 – 0 – 6: 05**

Full Marks: 100   **Theory:** 28/70   **Sessional:** 15/30

Unit I:

The Internet – concept, types, connections – structure and features of internet – Internet and Intranet, Protocols, Browsers, Search engines, Web structure, Web structure, Web blogs.

Unit II:

Internet services—URL, Dial—ups, ISDN, e-mail, chat, cross platform features, audio & video streaming, Internet applications—Audio & video conferencing, Internet telephony, virtual reality, artificial intelligence.

Unit III:

Fundamentals of web designing – tools – design techniques – Web site organization – file structure, naming conventions, pages, folders, navigation, hyperlinks and adding sound.

Websites – features – portals – content- corporate sites – commercial cites—functions.

Unit IV:

Content planning – Analysis – Objectives—Content strategies – developing content tactics – defining content matter.

Unit V:

Web authoring tools – Adobe Photoshop, Front Page, Dream weaver, Flash, using peripherals for website enhancements.

Adobe DreamWeaver—features – tools. Microsoft front page – features – tools.

Reference:

- Internet Bible, IDG Books, New Delhi, 1998.
- Internet for everyone, Leno et al., Lone Techworld, Chennai 1998.
- Building a website, Tim Worsley, Orling Kindersely, New Delhi, 2000.
- Web Designing Fundamentals, Daniel Gray, Dreantech Press, New Delhi,2000.
- Using the internet (4th Ed.), Prentice Hall, New Delhi,2000.
- How the Internet works, Millennium Edition by Preston Gralla
- Dreamweaver CS5: The Missing Manual – by David Sawyer McFarland, O'Reilly Press

Course Name: 3D Modeling		L – T – P: Cr
Course Code: AMT-403		2 – 0 – 6: 05
Full Marks: 100	Theory: 28/70	Sessional: 15/30

Unit I:

Getting in Control of 3D Space:

Menu commands, File menu, Edit Menu, Tools menu, Group Menu, View Menu, Main toolbar, working with viewports and files: Controlling the Viewports: Zooming a view, panning a view, rotating a view, Maximizing the active Viewports, MAYA Scene files, Importing and exporting files.

Unit II:

Basic Clay Modeling, Different tools available modeling, planning your model, Modeling Primitives, Maya Interface, Control the display of attributes in the Channel Box,

Unit III:

Introduction to polygons Modeling, Concepts NURBS ,Sub-divisional modeling, Merge polygons, Combine and Separate, Extract, Fill Hole, Loft option, Mirror Geometry, Polygons menus, normal, polygons Box, About selection, Duplicate polygon faces, Soft Selection, Smooth Mesh, Models for Games and Production, Boolean operation, Editing NURBS, Creating NURBS curves,

Unit IV:

Importing and Exporting files, Use Curve in 3D Modeling, Concepts of Sculpting, ,The out liner, Bounding Box, Concepts of Normal & Reveres, Blend Shapes, Two-manifold vs. non-manifold polygonal geometry High poly character Model, Low poly model, Gaming Models(Inorganic modeling, Organic modeling

Reference Books:

- Getting Started in 3D with Maya: Create a Project from Start to Finish: Model, Texture, Rig, Animate, and Render in Maya – by Adam Watkins
- Thinking Animation: Bridging the Gap Between 2D and CG – by Angie Jones, Jamie Oliff

Course Name: Texturing   L – T – P: Cr

Course Code: AMT-404   2 – 0 – 6: 05

Full Marks: 100   **Theory:** 28/70   **Sessional:** 15/30

UNIT: I

Introduction and Overview Of Photoshop: About Photoshop, Pixels and Vector Images, User interface, Creating new workspace, **Working with Selection:** Moving a selected area, Understanding Pixels & Resolution, Adjusting Images size, Cropping an Image, Adjusting Canvas Size and Canvas Rotation Working with Rulers, **Guides Painting In Photoshop:** Using the Brush tool, Working with colour and Swatches, Using Gradients, Working with Brushes, Using the Pencil & Eraser tools, **Vector Image Creation in Photoshop:** Using the Pen tool, Pen tool modifier Keys, Path Selection, Modifying paths, Creating Vector Shapes, Creating Custom Shapes

UNIT: II

Definition of Textures, Creating Textures, Using Texture Maps, RGB Colour, Introduction to UV Mapping, 2D Texture Positioning, 3D Texture Positioning, Shaders, Texture UV Mapping, Planar Mapping, Spherical Mapping, Cylindrical Mapping, Automatic Mapping.

UNIT: III

Texturing Tools, Materials, Material Editor, Hypershade, Bump Maps, Specular Shading Attributes, Incandescence Maps, Transparency Maps, Environment Sky Attributes, Colour Maps, Normal Maps, Character Texture, Props Texture, Environment Texture.

UNIT: IV

UV Texture Editor, Cut UV Edges, UV Lattice Tools, Matte Painting, Digital Painting, Ramp Shader Attributes, Texture Image, Displacement Map, 3D Motion Blur, Still Photography, Paint Effect.

Reference Books

- Advanced Maya Texturing and Lighting – by Lee Lanier

Course Name: Rigging		L – T – P: Cr
Course Code: AMT-405		2 – 0 – 6 : 05
Full Marks: 100	Theory: 28/70	Sessional: 15/30

UNIT I: Introduction

Basic Introduction to Rigging, Definition, Job of a Rigging Artist, Character Rigging in a 3D Production, Application and Approaches, Basic Concepts needed for Rigging, Pivot, Local and Global Rotation Axis, Parenting, Grouping, Parenting vs Grouping, Constraints, Types of Constraints and their uses.

UNIT II: Maya Skeletons

Understanding Joints, Definition, Creating and Renaming Joints, Exploring Joint Attributes and Joint Display Settings, Ways of Modifying Joint Rotation, Inserting and Removing of Joints, Use of Disconnect Joint Tool, Mirroring of Joints, Working with Controllers, Definition of Controllers, Curves as Controllers, Uses of Controllers, Connecting Controllers with Objects, Hiding unused Attributes, Bone Setup, Importing Character in Maya, Setting up Bones for Leg and Feet, Setting up Bones for Hand, Arm and Fingers, Setting up Bones for Spine, Neck and Head, Managing Hierarchies, Facial Bone Setup, Setting Controllers

UNIT III: Kinematics

Inverse Kinematics (IK), Introduction and Overview of IK, Solver Basics, End Effector, RP vs SC, Joint Tool, RP Handle, SC Handle, End Effector, Forward Kinematics (FK), Creating FK Controls on a skeleton which are Intuitive and Flexible, Add Attributes, Connection Editor, Channel Control, Expressions, Set Driven Key, Locator, Script.

UNIT IV: Character Set-up

Anatomy Study, Study of Human Skeleton, Starting to rig a Biped Character, Setting up the Skeleton, Introducing Controllers, Rigging the Leg and Feet using Reverse Foot, Rigging the Arm for IK and FK (IK/FK Switch), Rigging Fingers, Rigging the Torso, Neck and Head, Creating Character Set, Skinning the Character, Finalizing the Skin.

UNIT V: Skinning

Understanding Skinning, About Skinning, Smooth Binding and Rigid Binding, Deformers and Deformation Orders, Non-Linear Deformers, Binding and Painting Skin, Editing Skin Weight in Component Editor, Other Skinning Tools, Indirect Skinning.

Reference Books:

- An Essential Introduction to Maya Character Rigging by Cheryl Cabrera
- Inspired 3D Advanced Rigging and Deformations by Brad Clark, John Hood & Joe Harkins.
- Inspired 3D Character Setup by Michael Ford.

Course Name: 3D-Animation		**L – T – P: Cr**
Course Code: AMT-501		**2 – 0 – 6: 05**
Full Marks: 100	**Theory:** 28/70	**Sessional:** 15/30

UNIT I: Introduction

Meaning and Definition of animation, History of Animation, Uses of Animation, Types of Animation, Principles of Animation, Some Techniques of Animation, Ways to animate, Applications & Software of 3D Animation, 3D Animation in production.

UNIT II: Principles of Animation

Introduction, Squash and Stretch and Timing , Anticipation, Gesture: Staging and Exaggeration, Straight ahead action and pose to pose, Follow through and overlapping action, Slow in and slow out, Arcs, Secondary action, Timing, Solid drawing, Appeal, Flexibility, Weight, Spacing, Importance of timing and spacing.

UNIT III: Introduction to 3D Animation

Introduction to 3D software, Learning Interface of Maya, Working in 3D space**,** User interface **-** (Title bar, menu bar, status line the shelf, Toolbox, Workspace, Channel Box, Layer Editor, Time slider, Range slider, Command line, Script Editor button, Help line, Navigating a scene, Setting up a Project, Camera)

UNIT IV: Movements in Animation

Understanding Key Frames, Key Frame animation, Fine-tuning the animation. Representations of animation in the Timeline, Frame rates, Frame-by-frame animation, Camera animation, Non-Linear Animation, Motion Path Animation, Deformers, Key Frame Animation Flow Path Objects, Creating animation snapshots, Motion trail, Turntable.

UNIT V: Key Frame Animation

Keys, Extremes, Breakdowns, In-betweens, Blocking, Stagger timing, The side-to-side vibration formula, Whip action .Graph Editor, Text Editor, Dope Sheet, Cleanup and In-between, Introductory concepts to Basic Techniques in Animation.

UNIT VI: Posing

Pose, Primary Function of pose, Line of action, Reversing the line of action, Uses of vertical line of action, Flow lines, Proper weight in posing and Staging, Silhouette.

Reference Books:

Digital Character Animation 3 - by George Maestri

Timing For Animation - by Harold Whitaker and John Halas.

The Animator's Survival Kit - by Richard Williams.

Course Name: CG Lighting   **L – T – P: Cr**

Course Code: AMT-502   **2 – 0 – 6: 05**

Full Marks: 100   **Theory:** 28/70   **Sessional:** 15/30

UNIT I

Basics of Lighting, Color theory, Direct and Indirect Light, Types of Lights in Maya, 3-point Lighting, Light attributes, Shadows, Shadow Maps

UNIT II

Working with Layers, Rendering in Layers, Rendering in passes, Lighting Passes, Depth of Field, Cameras

UNIT III

Basics of Caustics, Mental Ray, Photons, Global Illumination, Raytracing, Final Gather

UNIT IV

Basic Lighting Techniques, Indoor and Outdoor lighting Techniques, Special Lighting Techniques, Materials and Rendering Algorithms

PRACTICAL

      I.   Lighting a 3D scene using 3-point Lighting
     II.   Lighting Indoor 3D scenes using all Maya Lights
   III.   Lighting Outdoor 3D scenes

Reference Books:

- Digital Lighting and Rendering I, II - by Jeremy Birn.

- Essential CG Lighting Techniques - by Darren Brooker

- Advanced Lighting and Materials with Shaders - by Kelly Dempski and Emmanuel Viale.

Course Name: Compositing	L – T – P: Cr

Course Name: Compositing **L – T – P: Cr**

Course Code: AMT-503 **2 – 0 – 6: 05**

Full Marks: 100 **Theory:** 28/70 **Sessional:** 15/30

UNIT I: Digital Compositing

     I.   What is Compositing?
    II.   Fundamentals of Digital Compositing.
   III.   Capturing through Fire wire.
   IV.   Various File Formats or video extensions.

UNIT II: Introduction to Adobe After Effects

     I.   Introduction to the interface of the Adobe After Effects.
    II.   Learning the toolbar.

UNIT III: Project Setting, Timeline, Layers

     I.   Composition settings in Adobe After Effects.
    II.   Organizing Image and Footages
   III.   Basic settings, Presets & Resolutions.
   IV.   Advanced settings, Rendering plug-ins.
    V.   Maintaining timing, spacing & proper play speed of video.
   VI.   Creating layers.
  VII.   Managing Layers & their Properties.
 VIII.   Switches, Blending modes & Layer styles.

UNIT IV: Key framing, Transitions

     I.   Basics of key framing (whether the video is in PAL or NTSC.)
    II.   How to move & copy keyframes.
   III.   Animate the keyframes.
   IV.   Adding the keyframes.
    V.   Learning about the transition effect & transition completion.
   VI.   Learning transition gallery.

UNIT V: Video Effects & Motion

     I.   Colour correction tools
    II.   Text animation and Presets.
   III.   Virtual cameras, lights.

UNIT VI: Output

      I.   Learning supporting output video formats.
     II.   Work with output module settings.
   III.   Rendering and exporting.
   IV.   Render Queue panel.
    V.   Encoding & compression options for movies.
   VI.   Rendering final movie.
  VII.   Video & audio Editing & merging.

PRACTICAL

   IV.   Creating a composition
    V.   Arranging and managing layers.
   VI.   Importing PSD file and animate layers.
  VII.   Text animation applying presets.
 VIII.   Applying colour correction tools to a video/image.
   IX.   Create composition using camera & lights.
    X.   Create a beautiful frame/composition using blending modes.

SUBMISSIONS

30 Sec. Composited Project.

Course Name: Visual Effects   **L – T – P: Cr**

Course Code: AMT-504   **2 – 0 – 6 : 05**

Full Marks: 100   **Theory:** 28/70   **Sessional:** 15/30

UNIT I: Introduction to Visual Effects (VFX)

Basic concepts of Maya Dynamics.

UNIT II: Particle

Particle Tool, Create Emitter, Emit from Object, Make Collide, Goal, Instancer (Replacement)

UNIT III: Fluid Effects

Create 2D/3D Container, Create 2D/3D Container with Emitter, Add/Edit Contents, Create Ocean and Pond.

UNIT IV: Fields

Air, Drag, Gravity, Newton, Radial, Turbulence, Uniform, Vortex, Volume Axis.

UNIT V: Soft and Rigid Bodies

Create Active/Rigid Body, Create Soft Body, Create Nail Constraint, Pin Constraint, Hinge Constraint, Spring Constraint and Barrier Constraint.

UNIT VI: Hair and Fur

Create/Edit Hair and Fur.

PRACTICAL

   I.   Create beautiful tornado effect using particle tools.
  II.   Create fire using Fluid system.
 III.   Create Stormy Ocean.
 IV.   Create any effect using constraints
  V.   Create beautiful hair on a 3D model.

SUBMISSION

30 Sec. VFX movie.

Course Name: Audio and Video Editing　　　　　　　　　　**L – T - P: Cr**

Course Code: AMT-505　　　　　　　　　　　　　　　　　**2 – 0 – 6: 05**

Full Marks: 100　　　　　　　　**Theory:** 28/70　　　　　　**Sessional:** 15/30

UNIT I:

Audio Editing, MIDI, using Audio Editing tools like Nuendo, Cool Edit Pro, Ccube, Logic Pro, Creating Digital Audio, Synthesizing, Connecting Audio Cards to the system and mic, Firewire, Different Wires used to connect the peripherals, Voice-over recording, Equalizing Audio, Filters, Codecs.

UNIT II:

Linear and Non-linear Editing, on-line and off-line editing, in cam edit. Principles of editing-Matching actions, Continuity, Matching Tone, Cut in , Cut away, Jump cut, compression and expansion of time. Ingesting footage, making a project file, Project setting, Timeline operations, various project windows: canvas, transitions, effects, Filters and Toolbar.

UNIT III:

Thinking and conceptualizing a film; Planning and controlling the production; Significance of research in AV production process; From Idea to shooting scripts; Production team--Non-technical/above-the-line personnel, Technical/below-the-line personnel & crew.

UNIT IV:

Framing effective shots--Field of View, Headroom, Noseroom and Leadroom, Types of Camera angles, shots, movements and Image sizes, Single and Multi-camera shoots.

UNIT V:

Video Editing, Digital Video, Using tools like Final Cut Pro or Studio, Avid, Adobe Premier, Broadcast systems.

UNIT VI:

Embedding audio files, capturing video file from a DV tape, Timeline, Cropping and Cutting unwanted video footage, arranging the video sequence according to the script with or without voice over, Transitions, Enhancements, Color Corrections. Importing or exporting files.

PRACTICALS

1. Practice Camera angles, shots, movements and Image sizes.
2. Handling the equipment; Camera mounting equipment; Handheld and Shoulder-mounted camera; Camera mounting heads; Special mounting devices--high hat, Bean bag, Steadycam, Short & long Jibs.
3. Take shots, capture. And arrange footages.
4. Video Editing using editing tool Final Cut Pro(Cropping and Cutting unwanted video footage, arranging the video sequence according to the script with or without voice over, Transitions, Enhancements, Color Corrections. Importing or exporting files.)
5. Audio Editing using editing tool Nuendo (Recording, capturing, arranging and editing)

Course Name: Minor Project   **L – T – P: Cr**

Course Code: AMT-599   **0 – 0 – 6 : 03**

A group of students will be given a small project which may be a short movie, animated or live footage, which should reflect all the pre-production, production, post-production stages and should contain original audio and videos.

SUBMISSION:

- Project Report
- Video of Documentary/Short Movie

Course Name: Industrial Management and Entrepreneurship   L – T – P: Cr

Course Code: Hu-601   3 – 1 – 0 : 03

Total Marks: 100   **Theory:** 28/70   **Sessional:** 15/30

INDUSTRIAL MANAGEMENT :

UNIT - 1:

Meaning and concept of Management, Principles and functions of Management, Labour turnover, Payment of wages – factors determining the wage, Methods of payment of wages.

UNIT - 2:

Leadership and Decision Making, qualities and styles of Leadership, decision making process.

UNIT - 3:

Elements of costs, Analysis and classification of expenditure for cost accounts, preparation of cost sheet, Marginal costing and Break Even Analysis.

UNIT - 4:

Factories Act -1948, Definitions, Main Provisions regarding Health, Safety and welfare of workers.

UNIT - 5:

Industrial Dispute Act – 1947, Definitions, Preventive measure, Machinery for settlement of Industrial Dispute in India.

UNIT - 6:

Trade Union Act - Meaning and function of Trade Union.

ENTREPRENEURSHIP:

UNIT - 7:

Meaning and function of Entrepreneurship

UNIT - 8:

Forms of Business organization: Sole Trader, Main features, merits and demerits, Partnership – main features, merits and demerits. Joint stock company – main features, difference between private and public limited companies. Introduction to co-operative and public undertaking.

UNIT - 9:

Small scale industries: Definitions, scope with reference to self-employment, procedure to start small scale industries, Sources of finance - Bank, Government and Financial institutions etc. Selection of site for factories, Industrial Estate, Growth Centre, Ancillary Industries.

UNIT - 10:

System of Distribution – Wholesale and Retail Trade.

References :

1. General Principle and Practice of Management – L M Prasad

2. Management Concepts and Practice – Kanchan Bhatia and Shweta Mittal

3. Micro Economics – Sandeep Garg

4. Self-Employment through Entrepreneurship – J.C. Kalita

5. Entrepreneurship Development & Small Business Management – Dr. Bhawna Bhatnagar and Ankur Budhiraja.

6. Labour and Industrial Law of India – S.K. Misra

7. Industrial Safety and Health for Administrative Services---Charles D. Reese

8. Entrepreneurship –D D Mali and J.C. Kalita

Course Name: Computer Programming with C/C++ **L–T–P: Cr**

Course Code: CAI-605 **3–0–4: 05**

Full Marks: 100 **Theory:** 28/70 **Sessional:** 15/30

Unit l Introduction to salient features of C, C-tokens, data types in C, types of variables, declarations, type casting and expression Control flow-branching and looping.

Unit ll Functions – pass by value, pass by reference and program structure, string manipulation pointer and array, Passing pointers as arguments in function.

Unit lll Structural input and out file handling, UNIX system interferences, Special features of C

Unit lV Object oriented programming, data encapsulating, inheritance & overloading

Unit V File handling with C++, constructors, destructors, Special features of C++

REFERENCE BOOKS:-

Sl. No.	Author, Publisher and Address	Edition, Year of Publication	Title
1.	Balaguruswamy Tata McGraw Hill New Delhi	Ed. 1997	Programming in ANSI C
2.	Byron Gottfried McGraw Hill International, New York	Ed. 1996	Programming with C
3.	Kernighan B W & Ritchie Denison, Prentice Hall of India, New Delhi	Ed. 1990 2nd Ed.	The C Programming Language
4.	Robert Lafore, Galgotia Publications, New Delhi.	Ed. 1991	Object oriented Programming in TURBO C++

Course Name: Specialization-I   **L – T – P: Cr**

Course Code: AMT-60*   **2 – 0 – 8: 06**

Full Marks: 100   **Theory:** 28/70   **Sessional:** 15/30

Specialization:

Students would have to choose a particular stage/field of Animation or Multimedia from the list below and accordingly learn the production traits required to join a studio.

#1. **3D Modeling**:   AMT-601

#2. **Rigging**:   AMT-603

#3. **CG Lighting**:   AMT-605

#4. **Visual Effects**:   AMT-606

Course Name: Specialization-I (3D Modeling)   L – T – P: Cr

Course Code: AMT-601   2 – 0 – 8: 06

Full Marks: 100   **Theory:** 28/70   **Sessional:** 15/30

UNIT-I

Polygon & NURBS Introduction, understanding NURBS, understanding Curves, Polygon Vertices, Polygon Edges, Polygon, Working with Smooth Polygons, Using Smooth Mesh Polygons, Editing Polygon Components, Using Soft Selection, Create the Shape for the Torso, Adding Components, Insert Edge Loops, Extruding Polygons, Edge Creasing, Mirror Cut.

UNIT-II

Creating and Editing Maya Nodes, Using the Hypergraph, Connecting Nodes with the Connection Editor, Creating Node Hierarchies in the Outliner, Displaying Options in the Outliner, The Channel Box, The Attribute Editor, Creating Maya Projects: Creating a New Project, Editing and Changing Projects, File References: Referencing a File, Using Reference Proxies.

UNIT-III

Virtual Filmmaking with Maya Cameras, Determining the Image Size and Film Speed of the Camera, Setting the Size and Resolution of the Image, Setting the Film Speed, Creating and Animating Cameras, Setting Camera Attributes, Limiting the Range of Renderable Objects with Clipping Planes.

UNIT-IV

Create organic and In-organic Model, Z Brush, Presentation in Basic Model, Seminar / Workshop, Make one Project Report.

SUBMISSION:

- Project Report.
- At least one Organic and one Inorganic Model

Course Name: Specialization-I (Rigging) **L – T – P: Cr**

Course Code: AMT-603 **2 – 0 – 8: 06**

Full Marks: 100 **Theory:** 28/70 **Sessional:** 15/30

UNIT I: Rigging in Computer Animation

About Rigging - Character rigging in 3D production, The job of a rigging artist, Important goals of a rigging artist, How digital rigging has evolved,

UNIT II: Anatomy Study

Study of human skeleton, Study of animal skeleton, The importance of research.

UNIT III: Intermediate Rigging

Rigging a wing, Rigging a cartoon character.

UNIT IV: Maya Muscles

Creating Maya muscle system, Using muscle creator to create and edit muscle, Modifying muscle bulge and jiggle, Sculpting muscle shapes, Painting muscle weight.

UNIT V: Advanced Rigging

Rigging a Quadruped character

UNIT VI: Scripting an advanced character GUI

Creating more GUI controls, Designing a character GUI, Working with layouts, Using intermediate layouts, Designing an advanced GUI

SUBMISSIONS:

- Project Report
- At least one rigged character

Reference Books:

- An Essential Introduction to Maya Character Rigging by Cheryl Cabrera
- Inspired 3D Advanced Rigging and Deformations by Brad Clark ,John Hood & Joe Harkins
- Inspired 3D Character Setup by Michael Ford

Course Name: Specialization-I (CG Lighting)   **L – T – P: Cr**

Course Code: AMT-605   **2 – 0 – 8: 06**

Full Marks: 100   **Theory:** 28/70   **Sessional:** 15/30

UNIT I

Color theory, Creating Moods, Advanced Lighting Techniques, Render Passes, Diffuse Pass, Specular Pass, Occlusion Pass, Shadow Pass, Reflection Pass, RGB Matte Pass, Rim Pass, Beauty Pass, Special Light Pass.

UNIT II

Advanced Outdoor Lighting Techniques, Creating Sky dome, Maya Renderer, Creating Light Rigs, Removing Artifacts, Advanced Indoor Lighting Techniques, Character Lighting, Spreadsheet Editor, Relationship Editors, Light-Linking, Light Centric, Object Centric, Make Shadow Link, Break Shadow Link.

UNIT III

Render Settings, Photons, Mental Ray Renderer, Caustics, Global Illumination, Raytracing, Special Lighting Techniques, Underwater Lighting, IPR Render, Batch Render.

SUBMISSIONS:

- Project Report
- Clip with at least one Indoor Scene and one Outdoor Scene (1-3 mins)

Reference Books:

- Digital Lighting and Rendering I, II - by Jeremy Birn.
- Essential CG Lighting Techniques - by Darren Brooker
- Advanced Lighting and Materials with Shaders - by Kelly Dempski and Emmanuel Viale.
- Advanced Maya Texturing and Lighting – by Lee Lanier
- Maya Studio Projects: Texturing and Lighting – by Lee Lanier

Course Name: Specialization-I (Visual Effects)   **L – T – P: Cr**

Course Code: AMT-606   **2 – 0 – 8: 06**

Full Marks: 100   **Theory:** 28/70   **Sessional:** 15/30

OBJECTIVE - *The main objective of the subject is to impart the theory & practical knowledge specialized skills and attitude to work in Animation field.*

UNIT I: Maya nDynamics

   I.   nParticles, Cloth Simulation with nCloth, nConstraint, nCache, nSolver.
  II. Designing Paint Effects – Coloring paints- Designing Trees and green effects – Designing Weather and seasons –Effects on seasons- Designing Glass image – Designing Different glass reflection- Designing Glow Effects – Liquid Effects and reflection design

UNIT II: Visual Effects Using Plug-ins

     I.   Learning the uses of particles, & dynamics.
   II. Different types of effect making like fire, dust, etc.
  III. 3D strokes and Lens flares.

UNIT III: Paint, Retouch & Wire removal

    I. The complete and advance study of the usage of paint and brush tools like brush, clone, stamp, eraser
   II. Wire/Rig Removal.

UNIT IV: Camera Matching, Tracking & Stabilizing

     I. Stabilization (The Repo Problem and Motion Smoothing)
    II. Camera Matching
   III. Motion Tracking Operation(Selecting good tracking targets, Enable/Disable Trackers, Keep Shape & Follow Shape)
   IV. Set Extension

UNIT V: Camera Projection

    I. Camera projection in After Effects
   II. Camera Projection in Maya.

PRACTICAL

I.	Create cloth simulation
II.	Create CG scene with the Paint Effect
III.	Create rain effect
IV.	Create fire effect
V.	Create cloud effect
VI.	Create special effects with Plug-in
VII.	Apply Rig Removal technique on your own footage
VIII.	Apply set Extension technique on your own footage
IX.	3D camera Projection

SUBMISSIONS

30 sec VFX movie.

Reference books:
- Special effects : The History & Techniques – Richard Rickitt, **Publisher:** Watson-Guptill
- Adobe After effects CS4 Visual effects & compositing studio techniques - Mark Christiansen. **Publisher:** Adobe Press.
- Maya Visual effects : The innovator's guide – Eric Keller Publisher: Sybex.
- Maya Documentation.
- Maya Studio Projects: Dynamics – Todd Palamar **Publisher**: Sybex.
- After Effects Documentation

Course Name: Specialization-II   **L – T – P: Cr**

Course Code: AMT-60*   **2 – 0 – 8: 06**

Full Marks: 100   **Theory:** 28/70   **Sessional:** 15/30

Specialization:

Students would have to choose a particular stage/field of Animation or Multimedia from the list below and accordingly learn the production traits required to join a studio.

#1. **Texturing**:   AMT-602

#2. **3D Animation**:   AMT-604

#3. **Compositing**:   AMT-607

Course Name: Specialization-II (Texturing)   **L – T – P: Cr**

Course Code: AMT-602   **2 – 0 – 8 : 06**

Full Marks: 100   **Theory:** 28/70   **Sessional:** 15/30

UNIT-I

Texture Mapping, UV Texture Layout, What are UV Texture Coordinates, Unfolding UVs, Mirroring UVs, Arranging UV Shells, Additional UV Mapping Considerations, Transferring UVs, Concept UV snapshot.

UNIT-II

Bump and Normal Mapping: Bump Maps, Normal Maps, Creating Normal Maps, Applying Normal Maps, Displacement Mapping, Concept Split, Cut UVs, Sew UV Edge, Relax UVs.

UNIT-III

Bit map or Raster Graphics Introduction, Interface, starting to work in Photoshop, Raster Designing and editing, Correcting Digital Photographs, and Concept Filter menu, Effect Menu, Creating a layer, Advanced Layer Style.

UNIT-IV

Create organic and In-organic Model Texture, Presentation in Basic Model, Seminar/ Workshop,

SUBMISSION:

- Project Report.
- At least one Textured Organic and one Inorganic Model

Course Name: Specialization-II (3D Animation) **L – T – P: Cr**

Course Code: AMT-604 **2 – 0 – 8 : 06**

Full Marks: 100 **Theory:** 28/70 **Sessional:** 15/30

UNIT-I: Character Animation working practice

Biped walk cycle, blocking the golden poses of walk and polishing, Run Cycle, blocking and refining the run cycle. Jump cycle blocking and refining.

UNIT-II: Body Mechanics

Focus on full body performance-based animation, Animation in Layers.

UNIT-III: Animation of Acting I –body language

Method acting , theatrical acting, Emotions, Laban Movement theory, eight basic efforts, general body language, basic body postures- open, closed, forward, and back body postures, palm, hand and leg gestures.

UNIT-III: Animation of Acting II –Facial expression

eye brow movements, eye direction, eye lid movement, blink, mouth and jaw movements, cheek movements, nose movements, emotions, facial expressions- happiness, smile, sadness, surprise, fear, anger, pain distress, combination of facial expressions, head angles, hand to face gestures.

UNIT-IV: Lip sync

Principles of lip sync, Mouth shapes, consonants, the vowels, the quieter vowels and consonants, mouth corners, importing audio tracks, breaking down a dialogue track, acting with dialogue.

SUBMISSION:

- Project Report.
- At least one Animated Character

Reference books:

- Animation Survival Kit by Richard Williams

- Drawn to life, vol I and II by Walt Stanchfield

- Acting for Animators by Ed Hook

- Inspired 3D character animation by Kyle Clark and Michael Ford

- Tony White's Animator's Notebook by Tony White

- Understanding 3D Animation using Maya by John Edgar Park

Course Name: Specialization-II (Compositing)   **L – T – P: Cr**

Course Code: AMT-602   **2 – 0 – 8 : 06**

Full Marks: 100   **Theory:** 28/70   **Sessional:** 15/30

OBJECTIVE - *The main objective of the subject is to impart the theory & practical knowledge about Digital Compositing & Post Production of various media.*

UNIT I: Advance Digital Compositing

   I.   3D Compositing.
   II.   Compositing real-life shoot with CG (Computer Generated) characters or Environment.
   III. Blending of CG (Computer Generated) lights & cameras with real shoot.
   IV.   Multi-layer compositing(Create Earth Zoom Effect)
   V.   Concept of Parallax.

UNIT II: Video Effects & Motion

   I.   Color correction to videos.
   II.   Creating virtual animated backgrounds.
   III. Concepts for Broadcast animation for logos, channel IDs and montages.

UNIT III: Chroma Keying

   I.   Basics of Chroma keying.
   II.   Mattes
   III. Rotoscoping
   IV.   Blue/Green Screen Imaging.
   V.   Lighting Chroma Key Properly.
   VI.   Green screen, Blue screen removal.

UNIT IV: Render passes & 3D compositing

   I.   The study of render passes.
   II.   Multi-pass Compositing

PRACTICAL

   I.   Wire removals,
   II.   Rotoscopy.
   III. Colour correction

IV.   Tracking and stabilizing, Keying and compositing CG.
V.   Compiling passes
VI.   Title effects, applying various effects using Plug-ins
VII.   Create CG scene and composite with real life footage of your own.
VIII.   Morphing.

SUBMISSIONS

30 sec composited project.

Reference Books:

- Adobe After Effects Documentation.
- Digital compositing for film & video by Steve Wright, **Publisher:** Focal Press
- Professional digital compositing by Lee Lanier, **Publisher**:Sybex; Pap/Dvdr O Edition
- Adobe after effect visual effects & compositing by Mark Christiansen, **Publisher**: Adobe Press

Course Name: Major Project   **L – T – P: Cr**

Course Code: AMT- 699   **0 – 0 – 20: 10**

Students will have to do a major project with a guide who has specialized in the area the students have chosen to pursue. The major project would serve as their Show Reel or Demo Reel, which in turn would enable the student to apply for a position in any Animation/Multimedia Studio after they have passed out.

SUBMISSION:

- Project Report
- Video Show Reel/Demo Reel (1-3 min duration)