



ଓଡ଼ିଶା ରାଜ୍ୟ ମୁକ୍ତ ବିଶ୍ୱବିଦ୍ୟାଳୟ, ସମ୍ବଲପୁର, ଓଡ଼ିଶା
Odisha State Open University, Sambalpur, Odisha
Established by an Act of Government of Odisha.

**DIPLOMA IN ANDROID APPLICATION
(DAP)**

CSP-80

Fundamentals of Android Programming

Block

1

Introduction to Android

Unit -1

Basics of Android

Unit -2

Android Architecture

Unit -3

Activity Lifecycle



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EXPERT COMMITTEE

Dr. Manas Ranjan Senapati Associate Prof., Dept. of IT VSSUT, Burla	(Chairman)
Dr. Santosh Kumar Majhi Assistant Prof., Dept. of CSE VSSUT, Burla	(Member)
Mr. Atul Vikash Lakra Assistant Prof., Dept. of IT VSSUT, Burla	(Member)
Mr. Aseem Kumar Patel Academic Consultant (I.T), Odisha State Open University, Sambalpur, Odisha	(Convener)

DIPLOMA IN ANDROID APPLICATION

Course Editor

Aseem Kumar Patel
Academic Consultant (IT)
Odisha State Open University,
Sambalpur, Odisha

UNIT-01



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Course overview

Welcome to Introduction to Android

This course will enable you with basic computing skills to develop mobile applications with Android operating system. Fundamental concepts of Android, theoretical and practical knowledge to develop an app incorporating multimedia and security, and performance issues of Android are discussed here. At the end of this course, you should be able to design and develop a mobile app to solve a real world problem using Android.

Video V-0: Introduction to Android



A series of videos have been developed as supporting materials for the lessons given in this book. This video, ‘Course Overview’, gives a general introduction to this series of videos produced. You can view this at URL: <https://tinyurl.com/yicsrmtho>

Introduction to Android —is this course for you?

This course is intended for people who aspire to become mobile application developers using Android operating system..

You should have basic ICT skills to use a computer and knowledge of a programming language such as Java to become a competent programmer in Android..



Course objectives



Objectives

The objectives of this course are:

- to introduce learners to basic concepts in Android
- to enable learners design mobile applications using fundamental concepts in Android
- to enable learner to acquire skills in programming with Android
- to introduce learners to performance and security issues that arise when developing mobile applications

Course outcomes



Outcomes

Upon completion of Introduction to Android you will be able to:

- *explain* the functionality of components in Android operating system and how the states of an Android activity change when running an Android mobile application
- *identify* the components and structures of Android development environment and explain how and when to apply these components to develop a working application
- *design* Android mobile applications using an Android development environment with existing mobile device features
- *develop* Android mobile applications using an Android development environment with existing mobile device features and deploy in Android market
- *analyse* the limitations of a mobile application for a given range of mobile devices
- *use* different testing tools and techniques to inspect and debug an Android mobile application



Study skills



As an adult learner your approach to learning will be different to that from your school days: you will choose what you want to study, you will have professional and/or personal motivation for doing so and you will most likely be fitting your study activities around other professional or domestic **responsibilities**.

Essentially you will be taking control of your learning environment. As a consequence, you will need to consider performance issues related to time management, goal setting, stress management, etc. Perhaps you will also need to reacquaint yourself in areas such as essay planning, coping with exams and using the web as a learning resource.

Your most significant considerations will be *time* and *space* i.e. the time you dedicate to your learning and the environment in which you engage in that learning.

We recommend that you take time now—before starting your self-study—to familiarize yourself with these issues. There are a number of excellent resources on the web. A few suggested links are:

- <http://www.how-to-study.com/>

The “How to study” web site is dedicated to study skills resources.

- <http://www.howtostudy.org/resources.php>

Another “How to study” web site with useful links to time management, efficient reading, questioning/listening/observing skills, getting the most out of doing (“hands-on” learning), memory building, tips for staying motivated, developing a learning plan.

The above links are our suggestions to start you on your way. At the time of writing these web links were active. If you want to look for more go to www.google.com and type “self-study basics”, “self-study tips”, “self-study skills” or similar.

Need help?



This course is offered by the Department of Electrical and Computer Engineering of The Open University of Sri Lanka for registered students. If you need help regarding this course and if you are a registered student at OUSL, please contact:



Unit 1

Introduction to Android

Introduction

The purpose of this study unit is to give you the first glimpse of the popular Android operating system for mobile devices and tablets. It is designed to empower mobile software developers to write innovative mobile applications. First part of this unit looks at the version history of the Android mobile operating system. Hence, you will be able to compare different mobile operating systems with unique features of Android.

The next part of the unit will help you to identify the devices that run Android as the Operating System with its open and customizable nature. Furthermore, at the end of this unit, you would be able to have an idea about the available categories of applications in Google Play.

One video material will be provided with this unit and you are expected to watch this and complete the relevant activities.

Upon completion of this unit you should be able to:

- describe how versioning and naming of Android Operating Systems has evolved.
- explain the unique features of Android OS comparing to existing mobile Operating Systems.
- identify the devices that run Android as the Operating System.
- identify the types of applications run on top of Android devices.



Outcomes



Terminology

IDE:	Integrated Development Environment to write, compile and and execute programs
app:	mobile application software
API:	Application Program Interface is a set of protocols and tools for building software
Kernel	essential core of an operating system



1.1 Android as a popular mobile platform

Android is an open-source operating system for mobile devices such as smart phones, smart watches, tablets, and other Android enabled platforms including Android TV and Android Auto. Android Auto is a smartphone projection standard developed by Google to allow mobile devices running the Android operating system (version 5.0 "Lollipop" and later) to be operated in automobiles through the dashboard's head unit. Android is a Linux based operating system.

"Android is the first truly open and comprehensive platform for mobile devices. It includes an operating system, user-interface and applications - all of the software to run a mobile phone, but without the proprietary obstacles that have hindered mobile innovation."

-By Andy Rubin (Founder of Android Inc.)

In other words, Android can be defined as a system that includes an open source operating system, an open source development platform and devices that run the operating system and applications created for it.

In the next section, we will be discussing about the popularity of Android OS among people.

Rapid innovation

Android is continuously pushing the boundaries of hardware and software forward, to bring new capabilities to users and developers. For developers like you, the rapid evolution of Android technology lets you stay in front with powerful, differentiated applications.

Android gives you access to the latest technologies and innovations across a multitude of device form factors, chipset architectures, and price points. If you are not familiar with the terms, a form factor is the size, configuration, or physical arrangement of the device and a price point is a point on a scale of possible prices at which something might be marketed. The range of features further includes multicore processing and high-performance graphics, state of the art sensors, vibrant touch-screens, and emerging mobile technologies.

Powerful development framework

Android facilitate you with everything you need to build best-in-class app experiences. It gives you a single application model that lets you deploy your apps broadly to hundreds of millions of users across a wide range of devices from phones to tablets and beyond.

Android also gives you tools for creating apps while taking advantage of the hardware capabilities available on each device. It automatically adapts your User Interface (UI) to look its best on each device, and gives you control over UI on different device types. This is further discussed later in this material.



For example, you can create a single app binary that's optimized for both phone and tablet form factors. What is a single app binary and how a single app binary can be deployed is discussed in a later unit of this material. Android allows you to declare your UI in lightweight sets of Extensible Markup Language (XML) resources, one set for parts of the UI that are common to all form factors and other sets for optimizations specific to phones or tablets. How UI designing is done is further explained in a later unit of this material. At runtime, Android applies the correct resource sets based on its screen size, density, locale, and so on.

To help you develop efficiently, the Android Developer Tools offer a full Java Integrated development environment (IDE) with advanced features for developing, debugging, and packaging Android apps. Using the IDE, you can develop on any available Android device or create virtual devices that emulate any hardware configuration.

Video V-1: Course Overview



You may watch the video on “course overview” before moving further and answer the questions in Activity 1.1.

URL: <https://tinyurl.com/ydhf7mf6>



Activity



Activity 1.1

Check the Android version, i.e. Kernel version, in an Android phone.

What are the other devices you have seen having Android operating system?

1.2 History of Android

In October, 2003, four computer experts, Andy Rubin, Nick Sears, Rich Miner and Chris White founded a software development organization Android Inc. in Palo Alto, California, USA. They wanted to make a Linux based operating system that can work on digital cameras which can connect with computers. However, this plan was not as successful as they thought, so they focused on smart phones.

In August, 2005, Google purchased the Android Inc. and became the



proprietor of the company. In November, 2007, Google disclosed a consortium of different mobile technology providers named Open Handset Alliance (OHA) that includes mobile hardware manufacturers (HTC, Motorola etc.), chipset manufacturers (Qualcomm, Texas Instruments etc.), and telecommunication service providers (T-Mobile etc.). There were 34 different companies in OHA consortium that agreed to provide a mobile device which does not belongs to a single company as iPhone from Apple. But for couple of years Google could not bring any mobile under the OHA consortium. In October, 2008, HTC brought first smart phone “HTC Dream” in the market which was commercially available. At the time when the first version of the Android was unveiled, only 35 Android apps were accessible. But today, millions of Android applications are available in the market.

Android has been released in many versions since its inception. Before commercialization, many internal alpha versions were released on the name of fictional robots (like Astro Boy, Bender, R2-D2 etc.). On November 5, 2007 Google released first beta version of Android whose Software Development Kit (SDK) was released on November 12, 2007. Since then, November 5th is considered as Android’s Birthday.

Version History

All versions of Android are released under a confectionary or sweet theme; i.e. names of the Android versions are the name of confectionary product in alphabetic order. It started with Android 1.5 "Cupcake"; versions 1.0 and 1.1 (API version 1 and 2) and they were not released under explicit code names.

API level is mainly the Android version used as an alternative to the Android version name (e.g. 3.0, 4.0, 4.4, etc.) where integer numbers are applied. This number keeps on increasing with each version, for e.g. Android 1.5 is API Level 3; Android 1.6 is API Level 4, and so on. Figure 1.1 shows the details of evolution of Android with product name, version name, release date and API level. The video *V-2 Evolution of Android* will also take you through the different phases of Android in an interesting manner.

Video V-2: Evolution of Android



Let us watch the vide on “Evolution of Android” before moving further and answer the questions in Activity 1.2.

URL: <https://tinyurl.com/ydhf7mf6>





Figure 1.1: Android Version Evolution

(Source: Graphic Era Hill University, Dehradun, India. 2016, CC BY 4.0)

With their main features, different versions of Android are summarized in the following Table 1.1. You need not to worry if you are not familiar with the terms given under features. You can refer this table while reading the remaining units of this material as when required.



Table 1.1: Version history of Android

	Version Name	Features
1.	API Level 1	This was the first commercial version of Android implemented on the mobile device HTC Dream. There were many features such as Android Market, Web Browser, Digital Camera, Gmail, Google Maps, Google Search, Google Talk, Voice Dialer, Google Contacts, Google Calendar, Media Player, Wi-Fi and Bluetooth support.
	API Level 2	This version was internally known as “Petite Four”. This version resolved many bugs of the previous version and added additional features like saving attachment in messages, show and hide dial pad etc.
2.	Cupcake	This was the first version whose code name was on the name of a bakery product. Cupcake was based on Linux Kernel 2.6.27. It had the features like third party virtual keyboard, screen widgets, copy and paste in the browser, autorotation, upload facility on YouTube and Picasa, auto pairing for Bluetooth, video recording and playback in 3GP and MPEG-4 formats.
3.	Donut	This version was based on Linux kernel 2.6.29. Donut was having the capability of speech and gesture support, selecting the multiple photos for deletion, support for WVGA screen resolution, etc.
4.	Éclair	First version of Eclair (API Level 5) was having features like Microsoft Exchange email support, Bluetooth 2.1, HTML5, Google Map 3.1.2, Live wallpapers, optimized hardware speed, support for more resolutions, double tap zoom, camera features like flash support, digital zoom, white balance, colour effect, etc.
5.	Froyo	It was based on Linux kernel 2.6.32. and was having the features like JIT compilation, Android Cloud to Device Messaging (C2DM), push notification, USB tethering and Wi-Fi hotspot, support for alphanumeric passwords, installing apps in external memory, Adobe Flash support. It is also known as “Frozen Yogurt”.



6.	Ginger-Bread	It was based on Linux kernel 2.6.35. First version of Gingerbread (API Level 9) was having updated user interface, support for WXGA resolution, NFC and native code development; new download manager, concurrent garbage collection, native support for new sensors like Gyroscope and Barometer, etc.
7.	Honeycomb	It was the first tablet oriented Android update based on Linux kernel 2.6.36. “Motorola Xoom” tablet was the first device to run this update. This version was having the features like holographic interface, System Bar, Action Bar, soft navigation button at the bottom of the screen, two pane contact and email UI, support for multi-core processors, encryption of all user data, etc. Second and third versions of Honeycomb were Android 3.1 (API Level 12) and Android 3.2 (API Level 13) with some bug fixes and enhancements.
8.	Ice Cream Sandwich	It was based on Linux kernel 3.0.1. It was the last version that was supporting Adobe Flash Player. First version of Ice Cream Sandwich (API Level 14) was having the features like accessing app from lock screen, real time speech to text dictation, face unlock, built-in photo editor, Wi-Fi Direct, shut down app by swipe from recent menu, integrated screenshot capture, etc.
9.	Jelly Bean	First version of Jelly Bean (API Level 16) was based on Linux kernel 3.0.31. It was having “Buttery Smooth” UI and other advancements. Second version of Jelly Bean was Android 4.2 – 4.2.2 (API Level 17). It was based on Linux kernel 3.4.0 and with some features like Group Messaging etc. Third version of Jelly Bean was Android 4.3 – 4.3.1 (API Level 18) with some features like 4K resolution support, native emoji support, Dial pad auto complete, etc.



10.	Kitkat	First version of Kitkat was Android 4.4 - 4.4.4(API Level 19). This was based on Linux kernel 3.10. This was optimized for larger range of devices than previous versions. Recommended RAM for Kitkat is 512 MB but it can run on minimum 340 MB of RAM. It was having different advanced features such as public API for developing text messaging clients; disable access to battery by third party, very elegant UI and much more. Second version of Kitkat was Android 4.4W (API Level 20) which was designed for wearable extensions like smart watch.
11.	Lollipop	First version of Lollipop was Android 5.0-5.0.2 (API Level 21). It was based on Linux kernel 3.16.1 and built around material design under project Volta to improve the battery life. It supports 64 bit CPU, trace based Just in Time(JIT) compilation, refreshed lock screen and notification tray; third party apps can modify the external storage; recently used apps remembered after restarting the device; audio I/O through USB, smart lock features and HD voice calls. Second version of Lollipop was Android 5.1 (API Level 22) with official support for multiple SIM cards, high definition voice calls, replicate the silent mode which was removed in API Level 21, native Wi-Fi calling etc.
12.	Marshmallow	Marshmallow is based on Linux kernel 3.18.10. It is released under the code name Android M. This is the latest updated version of Android which is having the features like native figure print reader, App standby feature, Doze mode, Now on Tap feature, USB Type-C support, MIDI support, 184 new emoji etc
13.	Nougat	The latest version of Android with system behaviors to save battery and memory. It brings new features for performance, productivity and security. There are several advantages such as multi-window UI, direct reply notifications etc.

Activity



Activity 1.2

Write the Android version name corresponding to following distinct features of different versions.



1. First version whose name was on the name of a bakery product.
2. First version having the capability of speech and gesture support.
3. First version that is having USB tethering and Wi-Fi hotspot.
4. This version can work on 340 MB RAM.
5. This version is built around the API level 5.
6. This version enables multi-window UI.

In the next section we will be discussing the features of Android.

1.3 Features of Android

Android is a powerful operating system with many supporting features for mobile application developers. Few of them are listed below in Table 1.2.

Table 1.2: Features of Android

Feature	Description
UI	Android provides a variety of pre-built UI components such as structured layout objects and UI controls to build the graphical user interface for your app. Android also provides other UI modules for special interfaces such as dialogs, notifications, and menus with its own unique effects and animations.
Connectivity	Android supports connectivity technologies including for Wide Area Networks (WAN) like GSM, 3G, 4G and CDMA. Also it is supporting for Wi-Fi and Ethernet as Local Area Network (LAN) technologies. Apart from that Android has support for Bluetooth as a Personal Area Network (PAN). Also newer versions support for Near Field Communication (NFC).



<p>Storage</p>	<p>Android provides several options for you to save persistent application data. The solution you choose depends on your specific needs, such as whether the data should be private to your application or accessible to other applications (and the user) and how much space your data requires.</p> <p>Your data storage options are the following: Shared Preferences, Internal Storage, External Storage, SQLite Databases, Network Connection, Cloud storage</p>
<p>Media support</p>	<p>Media format support built into the Android platform.</p> <p>Audio - MP3, MIDI</p> <p>Images – JPEG, GIF, PNG, BMP</p> <p>Video - MPEG-4 SP</p> <p>(More media format support built into the Android platform will be discussed in future units)</p>
<p>Feature</p>	<p>Description</p>
<p>Messaging</p>	<p>Short Message Service (SMS) and Multimedia Messaging Service (MMS). Google Cloud Messaging (GCM) is also a part of Android Push Messaging services.</p>
<p>Web browser</p>	<p>The web browser available in Android is based on the open-source Blink (previously WebKit) layout engine, coupled with Chrome's V8 JavaScript engine. It supports both Hyper Text Markup Language (HTML5) and Cascading Style Sheets (CSS3).</p>
<p>Multi-touch</p>	<p>A multi-touch gesture is when multiple pointers (fingers) touch the screen at the same time. Android has native support for multi-touch.</p>
<p>Multi-tasking</p>	<p>Multitasking — running multiple tasks simultaneously.</p> <p>When an activity has been launched, the user can go to Home and launch a second activity without destroying the first activity. User can jump from one task to another and same time various applications can run</p>



	simultaneously.
Resizable widgets	<p>App Widgets are miniature application views that can be embedded in other applications (such as the Home screen) and receive periodic updates. These views are referred to as Widgets in the user interface, and you can publish one with an App Widget provider.</p> <p>Resizing allows users to adjust the height and/or the width of a widget within the constraints of the home panel placement grid. You can decide if your widget is freely resizable or if it is constrained to horizontal or vertical size changes.</p>
Multi-Language	It is always a good idea to make the app localized and Android supports multiple languages.
Android Beam	Android Beam is a device-to-device data transfer tool that uses NFC and Bluetooth to send photos, videos, contact information, links to webpages, navigate directions and more from one device to another just by bumping them together. Android framework APIs supports these features.

Next, we will be comparing Android with other existing mobile operating systems.

1.4 Comparison of mobile Operating systems

Google's Android, Apple's iOS, Microsoft's Windows and BlackBerry Ltd's Blackberry are operating systems used primarily in mobile devices, such as smartphones and tablets. The popular mobile operating systems are very similar in some ways. Every OS supports some kind of mobile device management, but the way each OS supports is different and one of the unique features of Android is its source model. Android has its unique features when comparing with proprietary mobile operating systems. Table 1.3 shows a comparison of Android with one of the proprietary operating system, iOS.



Table 1.3: Comparison of mobile operating systems

	Android	iOS
Developer	Open Handset Alliance	Apple Inc.
Initial release	September 23, 2008	July 29, 2007
Source model	Open source	Closed, with open source components.
Available on	Many phones and tablets, LG, HTC, Samsung, Sony, Motorola, Nexus, Google Glasses	iPod Touch, iPhone, iPad, Apple TV
Messaging	Google Hangouts	iMessage
App store	Google Play	Apple app store
Video chat	Google Hangouts	Facetime
OS family	Linux	Unix-like, based on Darwin
Programmed in	C, C++, Java	C, C++, Objective-C, Swift
Internet browsing	Google Chrome	Mobile Safari
Voice commands	Yes	Siri
Latest stable release	Android 6.0.1 (Marshmallow), (October 2015)	9.3 (March 21, 2016)



	Android	iOS
Device manufacturer	Google, LG, Samsung, HTC, Sony, ASUS, Motorola, and many more	Apple Inc

1.5 Devices that run Android as the Operating System

Android occupies a large section of the global mobile market.

Here is a list of devices, which already run Android.

- Watches
- Smart glasses
- Home Appliances – E.g.: Refrigerators, washing machines, oven
- Cars
- Cameras
- Smart TVs
- Game consoles
- Home automation systems
- Robots

Activity



Activity 1.3

Give reasons for Android operating system becoming very popular.

1.6 Categories of Android applications

Google Play is the premier marketplace for selling and distributing Android apps. When you publish an app on Google Play, you reach the huge installed base of Android.

Using the Google Play Developer Console, you can choose a category for your apps. Users can browse for apps by category using a computer (play.google.com) and the Play Store app.

There are many Android applications in the market. Some of the top categories are:

- Music
- Multimedia
- News
- Sports



- Travel
- Weather
- Books
- Finance
- Social Media

Unit summary



The objective of this unit is to introduce Android and its capabilities. In the first part of this unit, we discussed about the history of Android with the names of the various versions of the Android Operating System (OS). Then we discussed the features provided by Android to create mobile applications and compared different operating systems available for mobile devices. Android is a powerful Operating System that supports many applications in Smart Phones.

Reference

<https://developer.android.com/about/android.html> (CC-BY)