1.1 Introduction:

Design is a more upgraded version of engineering technique to solving problems, and its primarily analytical process related to drawing or drafting. Design is not just the actual layout, but also the analytical processes use to determine what should be design and how the design should be modified to better meet the requirement. [1]

Aircraft design is contain three main phases conceptual, preliminary and detail design. Conceptual design phase is a first and important phase also is very fluid processes; begin usually with set of requirement after that make first estimate of weight, find of the main parameter of aerodynamics and geometry configuration, outcome of conceptual phase is a concept or configuration which does not necessarily accompany any details. Preliminary design include develop design requirements, prepare development, process, and materials specifications, determine performance technical measures. Detail design phase it's a phase where the time for decision for entering full scale development, most important part of detail phase it's a production design. During detail design the testing effort intensifies. Detail design phase ends with fabrication of aircraft.[1]

A trainer is a class of aircraft designed specifically to facilitate in flight training of pilots and aircrews. The use of a dedicated trainer aircraft with additional safety features such as tandem flight controls, forgiving flight characteristics and a simplified cockpit arrangement allows pilots in training to safely advance their real-time piloting, navigation and/or war fighting skills without the danger of overextending their abilities alone in a fully featured aircraft.[2] 3

1.2 Motivation :

All countries with a national air force need an associated programmer for their pilot selection and training; therefore the commercial market for military training aircraft and system is large. Designing training aircraft is relatively straight forward as the technologies to be incorporated into the design are generally well established. Many countries have produced indigenous aircraft for training as a mean of starting their own aircraft design and manufacturing industry. This has generated much different type of training aircraft in the world. For many different reasons only a few of these designs have been commercially successful in the international market.

1.3 Objectives:

This project aims to:

- Perform the conceptual design of the trainer aircraft.
- Calculate stability and performance of the aircraft.
- Calculate design by using analytical methods and computational programs.
- Fabricate model of the aircraft.

1.4 Methodology:

Methods used in design steps are classified to analytical and computational methods.

1.4.1 Analytical method:

This method includes all equations all their assumption using in steps of the conceptual design.

1.4.2 Applied and Computational Methods:

Microsoft excel: is a spreadsheet application developed by Microsoft for Microsoft Windows and Mac OS. It features calculation, graphing tools, pivot tables, and a macro programming language called Visual Basic for Applications.

Auto CAD: An AutoCAD is a computer aided design program that is used for drafting 2-D and 3-D designs. This program is developed and marketed by Autodesk Inc. and it was among the first programs that could be used on personal computers.

DATCOM: DATCOM is a computer program that implements the methods contained in the USAF Stability and Control DATCOM to calculate the static stability, control and dynamic derivative characteristics of fixed-wing aircraft. Digital DATCOM requires an input file containing a geometric description of an aircraft, and outputs its corresponding dimensionless stability derivatives according to the specified flight conditions. The values obtained can be used to calculate meaningful aspects of flight dynamics.

CATIA: CATIA is stands for Computer Aided Three-dimensional Interactive Application. CATIA is the most powerful Knowledge based and widely used CAD (computer aided design) software of its kind in the world. CATIA has been created by Dassault Systems of France and is marketed & technically supported worldwide by IBM.

1.5 Gantt Chart

The Gantt chart for this project is shown in Figure (1-1).

Figure (1-1): Project Gantt chart

1.6 Thesis Outlines:

Chapter Two: Shows mission requirements and profile and also dealing with all conceptual design steps.

Chapter Three: contains details of the aircraft aerodynamic analysis, also discussing the aircraft performance at different situation and the calculation for its performance parameters, including calculation stability of the aircraft.

Chapter Four: contains the results and data from the previous chapters.

Chapter Five: Comprises conclusion and recommendations for future studies.

1.7 Literature Review:

1.7.1 Training phases:

There are two main areas for instruction, flight training and operational training. In flight training a candidate seeks to develop their flying skills. In operational training the candidate learns to use his or her flying skills through simulated combat, attack and fighter techniques.[2]

i. AB - INITIO Phase:

Typically, contemporary military pilots learn initial flying skills in a light aircraft not too dissimilar from civilian training aircraft. In this phase pilot candidates are screened for mental and physical attributes.[2]

ii. Basic Training Phase:

After the AB-INITIO phase a candidate may progress to basic trainers/primary trainers. These are usually turboprop trainers like the Pilatus PC-9 and Embraer Tucano. Modern turbo-prop trainers can replicate the handling characteristics of jet aircraft as well as having sufficient performance to assess a candidate's technical ability at an aircraft controls, reaction speed and ability to anticipate events.[2]

iii. Advanced Training Phase:

Those that progress to training for fast jet flying will then progress to an advanced trainer, typically capable of high subsonic speeds, high-energy maneuver’s, and equipped with systems that simulate modern weapons and surveillance. Effective combat aircraft are a function now of electronics as much as if not more so than the aerobatic ability or speed of an aircraft. It is at this stage that a pilot begins to learn to operate radar systems and electronics. Modern advanced trainers feature programmable multi-function displays which can be programmed to simulate different electronic systems and scenarios.[2]

iv. Lead-in Fighter Training Phase:

Lead-in fighter training (LIFT) utilizes advanced jet trainer aircraft with avionics and stores-management capability that emulate operational fighter planes, to provide efficient training in combat scenarios with

reduced training cost compared to moving straight to operational conversion.[2]
v. **Operational Conversion Phase**:
Most military ground-attack or interceptor aircraft have two-seat trainer versions. These are combat capable operational conversion aircraft types to provide "on the job training" to pilots who have graduated to this level, and are usually available with little conversion in times of emergency to a reconnaissance or combat role.[2] In some two seat fighter aircraft such as the Tornado, the OCU aircraft can be created by duplicating flight controls in the rear cockpit. In normally single seat aircraft a second cockpit can be built behind the original cockpit (e.g. the TA-4S variant of the A-4SU Super Skyhawk) or the cockpit can be extended to place the instructor in a second seat behind the pilot. Once they have qualified in being able to fly a specific type of aircraft and have learned to use these aircraft to best effect, pilots will continue with regular training exercises to maintain qualifications on that aircraft and to improve their skills. The two seat aircraft may itself become the basis of an operational aircraft, the second seat being used to create a weapons officer navigators station in aircraft with originally only a pilot.[2]

1.7 .2 Historical Background for Similar Design:

i. K-8 Military Trainer Aircraft:

The JL-8 trainer was proposed as a joint cooperation effort between the governments of Pakistan and the People's Republic of China in 1986. The first prototype was built in 1989, with the first flight taking place on 21 November 1990. After four prototypes were built, production of a small batch of 24 aircraft was launched in 1992.

Airframe and flight control system.[3]

A low-wing monoplane design primarily constructed of aluminum alloys, the JL-8 / K-8 airframe structure is designed for an 8,000 flight hour service life. The landing gear is of tricycle configuration, with hydraulically operated wheel brakes and nose-wheel steering. The flight control system operates a set of conventional flight control surfaces with a rigid push-rod transmission system, which itself is electrically or hydraulically operated. Flight Instrument System (EFIS) is fitted, with multi-function displays (MFDs) in the front and rear cockpits showing information to the pilots. Ultra high frequency (UHF) and very high frequency (VHF) radio communication systems are present, along with a Tactical Air Navigation (TACAN) and automatic direction finder (ADF). An instrument landing system (ILS) is also available. The aircraft is powered by turbofan jet engine with 16.9 KN of thrust.[3]

Figure (1-2): Top, front and side view for K-8 military trainer aircraft

ii. L-39 Military Trainer Aircraft:

The L-39 under the name "Prototype X-02" – the second airframe built, first flew on 4 November 1969, Serial production began in 1971. Specification of this aircraft is low, slightly swept wing has a double-taper plan form, 2½-deg dihedral from the roots, a relatively low aspect ratio, and 100 liter (26½ US gal) fuel tanks permanently attached to the wingtips . The trailing edge has double-slotted trailing edge flaps. Swept vertical tail has an inset rudder. Variable-incidence horizontal stabilizers with inset elevators are mounted at the base of the rudder and over the exhaust nozzle. Operational g-force limits at 4,200 kg (9,260 lb.) are +8/-4 g. A single turbofan engine, an Ivchenko AI-25 TL (made in the Soviet Union) is embedded in the fuselage and is fed through shoulder-mounted, semi-circular air intakes just behind the cockpit. Five rubber bag fuel tanks are located in the fuselage behind the cockpit. The main, trailing-arm landing gear legs retract inward into wing bays; the nose gear retracts forward. The rear (instructor's) seat is raised slightly; both ejection seats are made by Aero. The basic trainer is not armed, but has two under wing pylons for drop tanks and practice weapons.[4]
Figure (1-3): Top, front and side view for L-39 military trainer aircraft

iii. MB-339 Military Trainer Aircraft:

In September 1972, Aermacchi was awarded a contract to study a replacement for the Italian Air Force's MB-326s, comparing seven all-new designs (given the designation MB-338) powered by various engines with an improved version of the MB-326, designated the MB-339. The MB-339 is of conventional configuration and all-metal construction, and shares much of the 326's airframe. It has a low, un-swept wing with tip tanks and jet intakes in the roots, tricycle undercarriage, and accommodation for the student and instructor in tandem. The most significant revision was a redesign of the forward fuselage to raise the instructor's seat to allow visibility over and past the student pilot's head. Over 200 MB-339s have been built, with roughly half of them going to the Italian Air Force. The Lockheed-Aermacchi MB-339 T-Bird II was a losing contender in the USA's Joint Primary Aircraft Training System (JPATS) aircraft selection. [5]
Figure (1-4): Geometry top, front and side view for MB-339 military trainer aircraft

1.7.3 Similar Approaches:

M. Ghoreyshi, A. Da Ronch, K. J. Badcock, J. Dees. Discussed Aerodynamic Modeling for Flight Dynamics Analysis of Conceptual Aircraft Designs by assesses the use of CFD level aerodynamics for the development of tables for flight dynamics analysis at the conceptual stage. A refined design passenger jet wind tunnel model is used as a test case, and three simplified conceptual versions of this geometry are generated. The influence of geometry approximations and modeling influences are evaluated to assess the usefulness of CFD for this application. Finally, the aerodynamic differences are assessed in terms of basic longitudinal flight dynamics analysis.[6]

Valery Razgonyaev and W.H. Mason .calculate An Evaluation of Aerodynamic Prediction Methods Applied to the XB-70 for Use in High Speed Aircraft Stability and Control System Design by using application of DATCOM and APAS to available XB-70 wind tunnel and flight test data. The study was carried out for the subsonic approach condition and three supersonic conditions. Results show that APAS and DATCOM predictions are good for most lateral/directional stability and control derivatives.[7]

HUANG Jun, M. I. Mustafa Compared with a delta wing aircraft, the double-delta wing configuration has better aerodynamic performance at high angles of attack. A method called Operational Analysis is used for the evaluation of training effectiveness. T raining effectiveness is taken as the objective function in this paper. Agreement of a calculation example with engineering practice indicates that the optimal design has higher training effectiveness than the baseline design, and in addition, improves the structural for cambering conditions. As conclusion compared with the original design, in addition to the training effectiveness increased, the Optimized design has a less- area outer wing, reduce structure mass and improve stress status of the fuselage force bearing frame. As an integrated evaluation criterion, the training effectiveness being used to assess the design of a fighter trainer aircraft will contribute a positive influence on the market competition capability of the newly designed trainer. With simple, easy use and high efficiency as their features, the semi-experiential and semi theoretical methods were adopted for the analysis of double - delta wing configured aircraft. Through appropriate correction, the calculation precision of these methods can meet the requirements for conceptual aircraft design. [8]

William B. Blake: Digital Dotcom is evaluated as a design tool for predicting the dynamic derivatives of fighter aircraft. Comparisons are made with wind tunnel data, flight test results. Strip theory predictions for four modern fighter configurations. Accuracy criteria taken for prior studies are used to judge the Digital Dotcom predictions. Are founded to be within the accuracy criteria. All comparisons except yaw damping.[9]

J.Kay, W. H. Mason, W. Durham, F. Lutze and A. Benoliela. Discussed the aircraft controllability requirements to be certified for commercial purposes adopted by the military. Many military aircraft also have additional maneuverability requirements. An aircraft's ability to meet these requirements is often limited by the amount of control authority available. As methodology to examine a variety of aircraft configurations and accelerate the process of estimating stability and control derivatives, a FORTRAN program using the vortex lattice method to estimate subsonic, low angle-of-attack aerodynamics is described,. Next a spreadsheet was created to assess whether the configuration possesses sufficient control power. As result applying this methodology should ensure that the conceptual design team can identify 13

deficient control power early in the preliminary design stage, when design modifications can be made without major complications.