



### w-extending and pw-extending Modules

Habit K. Mohammad ali, Mohammad E. Dabek

Department of Mathematics, College of Computer Science and Mathematics, Tikrit University, Tikrit, Iraq

## ARTICLE INFO

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**Corresponding Author:**

Name: **Mohammed E. Dabsh**

**Future work**

mailto:melhammadi2013@gmail.com

Table 1

## 1-Introduction

Throughout this paper all rings are commutative with identity and all modules are left unital module. A module  $X$  is called extending, if every submodule of  $X$  is essential in a direct summand of  $X$ . Equivalently that every closed submodule of  $X$  is a direct summand of  $X$  [1]., where a non zero submodule  $K$  of a module  $X$  is called essential if  $K \cap L \neq (0)$  for every non zero submodule  $L$  of  $X$  [2]. And a submodule  $K$  of a module  $X$  is called closed if  $K$  has no proper essential extension in  $X$  [2]. A submodule  $C$  of a module  $X$  is called weak essential if  $C \cap S \neq (0)$  for each non zero semi-prime submodule  $S$  of  $X$  [3]. A submodule  $K$  of a module  $X$  is called w-closed, if  $K$  has no proper weak essential extension in  $X$  [4]. A submodule  $L$  of a module  $X$  is called pw-closed if for each  $m \in M, m \notin L$ , there exists a w-closed submodule  $F$  of  $X$  with  $L \leq F$  and  $m \notin F$  [5]. Every w-closed submodule is a pw-closed submodule, while the converse is not true in general [5]. an  $R$ -module  $M$  is called multiplication if every submodule  $N$  of  $M$  is of the form  $N = IM$  for some ideal  $I$  of  $R$  [6]. An  $R$ -module  $Y$  is called fully semi-prime if every proper submodule of  $Y$  is a semi-prime [7]. An  $R$ -module  $M$  is called a completely essential if every non zero weak essential submodule of is essential [7]. Let  $Y$  be an  $R$ -module  $\text{ann}(y) = \{r \in R : ry = 0\}$ .

$Z(Y) = \{y \in Y : \text{ann}(y) \text{ essential in } R\}$  is called singular submodule of  $Y$  if  $Z(Y) = Y$ , then  $Y$  is

## Abstract

**I**n this work, we introduce and study two concepts of modules. The first one is a generalization of extending modules which is called a  $w$ -extending module. And the second concept is called  $pw$ -extending module which is a stronger property than  $w$ -extending. We give basic properties, example and characterization of these concepts. Moreover relationship of  $w$ -extending module and  $pw$ -extending modules with other types of modules are studied.

called singular module, if  $Z(Y) = (0)$ , then  $Y$  is called nonsingular module [2].

## 2. "W"-extended linear Modules

In this section, we introduce a new generalization of extending module called a  $w$ -extending module.

The following are the results of the analysis:

An  $R$ -module  $Y$  is called  $w$ -extending, if every submodule of  $Y$  is a weakly essential in a direct summand of  $Y$ . A ring  $R$  is a  $w$ -extending, if  $R$  is a  $w$ -extending  $R$ -module.

The following is a characterization of  $w$ -extending modules.

### Proposition 4.2.1

A module  $Y$  is a  $w$ -extending if and only if every  $w$ -closed submodule of  $Y$  is a direct summand of  $Y$ .

**Figure 1**

( $\Rightarrow$ ) Let  $E$  be a  $w$ -closed submodule of  $Y$ , then  $E$  is a weak essential in a direct summand of  $Y$  say  $L$ . But  $E$  is a  $w$ -closed in  $Y$ , then by [4, Prop.2.4]  $E=L$ . Hence  $E$  is a direct summand of  $Y$ .

( $\Rightarrow$ ) Let  $E$  be a submodule of  $Y$ . If  $E = \{0\}$ , then clearly  $E$  is a weak essential in a direct summand of  $Y$ . If  $E \neq \{0\}$ , then by [4, Prop.2.6], there exists a w-closed submodule  $L$  in  $Y$  such that  $E$  is a weak essential in  $L$ . Thus, by hypothesis  $L$  is a direct summand of  $Y$ , so  $E$  is a weak essential in a direct summand of  $Y$ . Hence  $Y$  is a w-extending module.

### Proposition (2.3)

# Extending Modules

**Saad H. Mohamed, Bruno J. Müller**



## Extending Modules:

*Extending Modules* Nguyen Viet Dung, Dinh Van Huynh, P F Smith, Robert Wisbauer, 1994-11-30 Module theory is an important tool for many different branches of mathematics as well as being an interesting subject in its own right Within module theory the concept of injective modules is particularly important Extending modules form a natural class of modules which is more general than the class of injective modules but retains many of its desirable properties This book gathers together for the first time in one place recent work on extending modules It is aimed at anyone with a basic knowledge of ring and module theory

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Module Theory, Extending Modules and Generalizations Adnan Tercan, Canan C. Yücel, 2016-05-13 The main focus of this monograph is to offer a comprehensive presentation of known and new results on various generalizations of CS modules and CS rings Extending or CS modules are generalizations of injective and also semisimple or uniform modules While the theory of CS modules is well documented in monographs and textbooks results on generalized forms of the CS property as well as dual notions are far less present in the literature With their work the authors provide a solid background to module theory accessible to anyone familiar with basic abstract algebra The focus of the book is on direct sums of CS modules and classes of modules related to CS modules such as relative injective ejective modules quasi continuous modules and lifting modules In particular matrix CS rings are studied and clear proofs of fundamental decomposition results on CS modules over commutative domains are given thus complementing existing monographs in this area Open problems round out the work and establish the basis for further developments in the field The main text is complemented by a wealth of examples and exercises

**Lifting Modules** John Clark, Christian Lomp, N. Vanaja, Robert Wisbauer, 2008-08-17 Extending modules are generalizations of injective modules and dually lifting modules generalize projective supplemented modules There is a certain asymmetry in this duality While the theory of extending modules is well documented in monographs and text books the purpose of our monograph is to provide a thorough study of supplements and projectivity conditions needed to investigate classes of modules related to lifting modules The text begins with an introduction to small submodules the radical variations on projectivity and hollow dimension The subsequent chapters consider preradicals and torsion theories in particular related to small modules decompositions of modules including the exchange property and local semi T nilpotency supplements in modules with specific emphasis on semilocal endomorphism rings finishing with a long chapter on lifting modules leading up their use in the theory of perfect rings Harada rings and quasi Frobenius rings Most of the material in the monograph appears in book form for the first time The main text is augmented by a plentiful supply of exercises together with comments on further related material and on how the

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2012 at The Ohio State University Columbus Ohio Included are expository articles and research papers covering topics such as cyclically presented modules Eggert's conjecture the Mittag-Leffler conditions clean rings McCoy rings QF rings projective and injective modules Baer modules and Leavitt path algebras Graduate students and researchers in many areas of algebra will find this volume valuable as the papers point out many directions for future work in particular several articles contain explicit lists of open questions

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On Structure of Prime Rings with Generalized Derivation A characterization of additive mappings in rings with involution Skew constacyclic codes over  $F_q[x]$  Generalized total graphs of commutative rings A survey Differential conditions for which near rings are commutative rings Generalized Skew Derivations satisfying the second Posner's theorem on Lie ideals Generalized Skew Derivations on Lie Ideals in Prime Rings On generalized derivations and commutativity of prime rings with involution On  $n$ -Krull property in amalgamated algebra Pure ideals in ordered semigroups Projective ideals of differential polynomial rings

over HNP rings Additive central m power skew commuting maps on semiprime rings A Note on CESS Lattices Properties Inherited by Direct Sums of Copies of a Module Modules witnessing that a Leavitt path algebra is directly infinite Inductive Groupoids and Normal Categories of Regular Semigroups Actions of generalized derivations in Rings and Banach Algebras Proper Categories and Their Duals On Nakayama Conjecture and related conjectures Review On construction of global actions for partial actions On 2 absorbing and Weakly 2 absorbing Ideals in Product Lattices Separability in algebra and category theory Annihilators of power values of generalized skew derivations on Lie ideals Generalized derivations on prime rings with involution

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Birkenmeier, Jae K. Park, Young S. Park, 2012-12-06 This volume is the Proceedings of the Third Korea China Japan International Symposium on Ring Theory held jointly with the Second Korea Japan Joint Ring Theory Seminar which took place at the historical resort area of Korea Kyongju June 28 July 3 1999 It also includes articles by some invited mathematicians who were unable to attend the conference Over 90 mathematicians from 12 countries attended this conference The conference is held every 4 years on a rotating basis The first conference was held in 1991 at Guilin China In 1995 the second conference took place in Okayama Japan At the second conference it was decided to include Korea who hosted this conference of 1999 During the past century Ring Theory has diversified into many subareas This is reflected in these articles from over 25 well known mathematicians covering a broad range of topics including Classical Ring Theory Module Theory Representation Theory and the theory of Hopf Algebras Among these peer reviewed papers are invited survey articles as well as research articles The survey articles provide an overview of various areas for researchers looking for a new or related field to investigate while the research articles give the flavor of current research We feel that the variety of related topics will stimulate interaction between researchers Moreover the Open Problems section provides guidance for future research This book should prove attractive to a wide audience of algebraists Gary F Birkenmeier Lafayette U S A **Advances In Ring**

**Theory - Proceedings Of The 4th China-japan-korea International Conference** Jianlong Chen, Nanqing Ding, Hidetoshi Marubayashi, 2005-08-22 The selected papers in this volume cover all the most important areas of ring theory and module theory such as classical ring theory representation theory the theory of quantum groups the theory of Hopf algebras the theory of Lie algebras and Abelian group theory The review articles written by specialists provide an excellent overview of the various areas of ring and module theory ideal for researchers looking for a new or related field of study Also included are original articles showing the trend of current research **Proceedings Of The Mathematics Conference** Fathi

Allen, Mohammad Saleh, Saber N Elaydi, Abid Elkhader, T Mughrabi, 2000-04-12 This volume covers topics ranging from pure and applied mathematics to pedagogical issues in mathematics There are papers in mathematical biology differential equations difference equations dynamical systems orthogonal polynomials topology calculus reform algebra and numerical analysis Most of the papers include new interesting results that are at the cutting edge of the respective subjects However there are some papers of an expository nature

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